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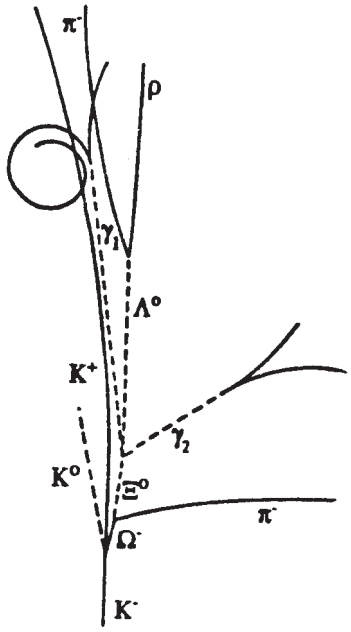

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THE NEW THEORY OF GRAVITY BASED ON MACH'S PRINCIPLE AND QUANTUM MECHANICS

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Abstract

This paper presents a new theory of gravity based on Mach's principle. New formulas are presented, in which the speed of light and Planck's constant depend on the distribution of all the matter in the Universe. A concept of Chaos is introduced as degenerate spacetime with indefinite laws of motion. A quantum mechanism of gravitation is proposed. The physical meaning of Einstein's formula for the connection of mass and energy is revealed. The equality of the inertial and gravitational masses is theoretically proved. The law of conservation of mass when moving in a gravitational field is presented. The formula for the gravitational potential is corrected. The formula for the mass defect in a gravitational field is derived. Equations for the size of an atom and its radiation frequency in a gravitational field are derived. Principal differences of the new theory from general relativity is discussed. An experiment is proposed to verify the new theory, which can be carried out in a modern metrology laboratory.

Keywords: Gravitation; Mach's principle; Quantum mechanics; Uncertainty; Speed of light; Planck's constant; Mass; Inertia; Gravitational potential; Atomic frequency; Atomic clock.

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1 Introduction

In many of his articles that preceded the creation of general relativity, Einstein paid much attention to Mach's principle. He stressed the importance of this principle for all physics. Einstein considered Newtonian mechanics and relativity theory to be untenable because these theories do not satisfy Mach's principle ([1], [2]). So, he sought to construct a theory in which Mach's principle would be fulfilled and hoped that general relativity would be such a theory.

However, as it turned out, general relativity does not contain Mach's principle. This is quite clear. If the general relativity contained Mach's principle, the basic equations of this theory would contain the distribution of all matter in the Universe, including the total mass of the Universe. According to Mach's principle it is the distribution of all the matter in the Universe that determines physical processes in near-Earth space. But the total mass of the Universe is absent in the equations of general relativity. Thus, Mach's principle is still an unresolved problem of physics [3]. Until now many attempts have been made to introduce this principle into the theory of gravity [4].

We will introduce Mach's principle into the theory of gravity in such a way that all physical processes in near-Earth space are completely determined by the distribution of distant galaxies and directly depend on the total mass of the Universe. We will calculate various interesting consequences from this. We will also consider an experiment that can be carried out using modern equipment to test these effects in a modern physical laboratory.

2 Mach's principle and fundamental constants

The foundation of all modern physics is Newtonian mechanics. The heart of Newtonian mechanics is Newton's first law, which asserts the following. If the body is not affected by forces, then this body moves at a constant speed along a straight line. The question arises: relative to what frame of reference does the body move at a constant speed? Answering this question Newton introduced the concept of absolute space, relative to which the movement of test bodies should be considered. Two centuries later Ernst Mach put forward the hypothesis that test bodies, which are not acted upon by forces, move at a

constant speed with respect to fixed stars. The stars with their huge mass somehow keep these bodies in a state of uniform motion.

According to Newton, the motion of test bodies is governed by absolute space. According to Mach, the motion of test bodies is governed by stars. What will happen if we remove the stars? For example, we will take them away to infinity. How will test bodies move in this case? They cannot move in a straight line? If in an absolutely empty space (there are no large massive objects) test bodies will obey Newton's first law, then Mach's principle is incorrect. If in an absolutely empty space test bodies will not obey Newton's first law, then Mach's principle is correct. How will the light propagate in this case? Will it move in a straight line or a curved one? Wolfgang Pauli in his famous monograph "Theory of Relativity", § 62, paid attention to Mach's principle. Based on this principle, Pauli concluded that in an absolutely empty space, the light could not propagate [5].

How to find out who is right, Newton or Mach? To answer this question, we need to introduce Mach's principle into modern physics and see to what new and interesting consequence this will lead. Then we must verify the correctness of new consequences in various experiments. If these experiments confirm new consequences, then it will be possible to conclude that Mach's principle is correct. Let us do that.

Newton's first law lies at the foundation of all physics. If this law is determined by the global distribution of matter in the Universe, then all the physics known to us is also determined by the global distribution of matter in the Universe. What does this mean? The various equations of motion include fundamental constants: the speed of light c, Planck's constant h, the mass m_e and the charge e of the electron, etc. We can assume that some of these fundamental constants somehow depend on the global distribution of matter in the Universe.

It is worth noting that Richard Feynman has already raised the question of the dependence of fundamental constants on the total mass of the Universe. Feynman was very sympathetic to Mach's principle and tried to introduce it into the theory of gravity. He believed that if Mach's principle is correct, then the spacetime scale in near-Earth space should be determined by distant galaxies. On the other hand, the spacetime scale can always be expressed in terms of the speed of light c, Planck's constant h, the mass of the electron m_e. For example, any standard of length is proportional to $h/m_e c$, and the time

standard is proportional to $h/m_e c^2$. We know that near a massive object the spacetime scale changes. Therefore, we can conclude that the speed of light c, Planck's constant h, an electron's mass m_e also somehow vary near a large mass. In this case, these fundamental constants should depend on the distribution of the massive objects in the Universe. Feynman discusses all these interesting ideas in his lectures on gravitation, especially in Chapter 5.4 "Mach's principle in quantum mechanics" [6].

Let us follow Mach's principle and Richard Feynman and we will suppose that the speed of light c, Planck's constant h, an electron's mass m_e depend on the global distribution of matter in the Universe. Based on this supposition, we will calculate how these physical quantities will vary depending on the height above the Earth's surface. Then we will find out how to test these calculations in experiments.

3 The Light formula and gravity

According to general relativity, light slows down near a massive object. For example, it is known due to numerous experiments that a radio signal passing near the Sun has a small delay [7]. Thus, the magnitude of the speed of light depends on the distance to the Sun. We can conclude that the magnitude of the speed of light also depends on the distance to other stars and galaxies and, consequently, is determined by the global distribution of matter in the Universe. The global distribution of matter in the Universe is determined by the gravitational potential created by the entire Universe in the near-Earth space. Therefore, we can conclude that the magnitude of the speed of light on Earth is determined by the gravitational potential of the entire Universe.

We can estimate the gravitational potential of the Universe based on astrophysical data on its size and density. Such estimations have been made many times. The result is as follows [6]. The absolute value of the gravitational potential of the Universe Φ is approximately equal to the speed of light c squared: $|\Phi| \approx c^2$. Moreover, some difference between these values is within the error of the observational date. Given this, we can write the dependence of the speed of light on the distribution of matter in the Universe as the following:

$$c^2 + \Phi = 0 \qquad (1)$$

Here, Φ is the gravitational potential of the Universe, normalized so as to tend to zero at a great distance from all the masses of the Universe, so the potential inside the Universe is negative: $\Phi < 0$.

We got a very interesting result. It follows from equation (1) that in an absolutely empty space the light cannot move because it will stop. At a great distance from all the stars and galaxies of the Universe: $\Phi = 0$, therefore $c = 0$. This was asserted by Pauli based on Mach's principle (read above). Equation (1) shows how the speed of light depends on the global distribution of the matter in the Universe. I propose to call this equation the Light formula.

Material bodies cannot move faster than light, so in an absolutely empty space all test bodies will stop. In our world, there is a difference between accelerated motion and inertia motion. According to Mach's principle, the cause of this difference is the stars and galaxies. In an absolutely empty space, there will not be such a difference because any movement will be impossible.

Each galaxy and star contributes a little to the value Φ. The depth of the gravitational potential of the Universe increases insignificantly near the Sun, the Earth and other massive objects. Thus, it follows from the Light formula (1) that the light accelerates near a massive object. This is directly contrary to general relativity. Therefore, the experimental confirmation of equation (1) not only will confirms the correctness of Mach's principle, but will also refutes general relativity.

However, the delay in a radio signal near the Sun has been confirmed in numerous experiments. Should we conclude that the Light formula (1) is wrong? Radar experiments are described in detail in the fundamental textbook "Gravitation" [7]. If we carefully read the descriptions of these experiments, it will become clear for us that in radar experiments the phase delay of the signal was measured. Consequently, the phase velocity of the radio wave was measured. Therefore, from all these experiments it can be concluded that the phase velocity of light decreases near the Sun and other massive objects. But it is well known that the group and phase velocities behave differently. Zakharenko discusses subject of the connection between the group and phase velocities in [8].

As an example, let us consider elementary particles. According to quantum mechanics, de Broglie wave is associated with each particle. The phase velocity of de Broglie wave is inversely proportional to the velocity of the particle. When the particle approaches the Earth its velocity increases, but the

phase velocity of its wave decreases. Photons behave in the same way as usual particles (electrons, protons etc.). For example, Richard Feynman wrote about this in his lectures on physics [9]. Therefore, we can expect that photons will accelerate in a gravitational field as well as usual particles. Accordingly, the phase velocity of waves associated with photons should decrease in a gravitational field in the same way as the phase velocity of waves associated with other particles decreases. This subject is discussed in [10].

Specialists in general relativity have conducted many experiments to measure the delay of a radio signal passing near the Sun. But they did not investigate at all what exactly they measured – a phase or group velocity? In this article we will consider an experiment that can answer the question, photons are accelerated or slowed down as they approach the Earth or another massive body. Such an experiment can be conducted in a modern metrology laboratory.

4 The Chaos formula and Mach's principle

We will express Planck's constant h in terms of the electron charge e, the speed of light c and the fine structure constant α:

$$h = \frac{2\pi e^2}{\alpha c} \tag{2}$$

It is known from numerous astrophysical observations that even in the distant past the fine structure constant $\alpha = e^2/c\hbar = 2\pi e^2/ch \approx 1/137$ did not differ (within the measurement error) from the present value [7]. The law of conservation of electric charge is the basis of Maxwell's electrodynamics. Therefore, we can assume that the electron charge does not change in the gravitational field. For example, according to general relativity, the magnitude of the electric charge does not depend on the gravitational potential and remains constant even in a black hole [7]. Using equations (1) and (2), we can conclude that Planck's constant varies in a gravitational field and depends on the gravitational potential of the Universe Φ as follows:

$$h = \frac{2\pi e^2}{\alpha \sqrt{-\Phi}} \tag{3}$$

Equation (3) can be represented as:

$$h^2\hat{O} = \text{const} \qquad (4)$$

According to quantum mechanics, there is an uncertainty in the motion of all bodies. This uncertainty is characterized by the magnitude of Planck's constant h. Planck's constant is very small and therefore the uncertainty in motion is also very small and is observed only in the microcosm. It follows from equation (4) that Planck's constant is determined by the global distribution of matter in the Universe and depends on the gravitational potential of the Universe Φ. Let us see what conclusions follow from this equation. For example, if we carry away galaxies and stars to infinity, the depth of the gravitational potential of the Universe will decrease, and Planck's constant will increase. So, the uncertainty in the motion of bodies will also increase. If all stars and galaxies are removed to infinity, the uncertainty in the motion of test bodies will be so high that all test bodies, including atoms, will break up into elementary particles. Since all our standards of time and length are based on the properties of the atom, the standards will lose their physical meaning. Due to the fact that the magnitude of Planck's constant will be very high, the values of the coordinate and momentum lose their physical meaning. The concept of energy and the concept of time will also lose physical meaning. Consequently, the notion of the reference frame will lose its physical meaning and therefore there will be no observable difference between the inertial frame of reference and the rotating frame of reference in full accordance with Mach's principle. We can conclude: as we approach the boundary of the Universe ($\Phi \to 0$), space and time will completely degenerate. We can say that spacetime degenerates into Chaos [11].

We are accustomed to space and time and perceive them as the basis of the whole Universe. From the new point of view, the spacetime, in which we live, exists only within the Universe due to stars and galaxies that fill the Universe. Our Universe is an island of space and time, surrounded by Chaos. When approaching Chaos ($\Phi \to 0$), Planck's constant increases indefinitely (4) and the speed of light tends to zero (1). When approaching Chaos, the laws of motion degenerate and spacetime loses its physical meaning.

As a rule, Mach's principle is given the following meaning. When moving away from large masses, the inertia of test bodies should tend to zero. It was this meaning that Einstein put into Mach's principle [12]. Equation (4) is a new

approach to Mach's principle: when moving away from large masses, the uncertainty in the motion of test bodies will increase unlimitedly. Why does the test body, on which forces do not act, move in a straight line at a constant speed? Because the stars and galaxies that fill the Universe limit the uncertainty in the movement of this body. Each star contributes a little to the magnitude of the gravitational potential of the Universe Φ, and thus reduces the magnitude of Planck's constant. If there were no stars and galaxies, then the concept of body motion by inertia would lose its physical meaning due to unlimited growth of uncertainty.

Any building will collapse if you remove the foundation from under it. Newton's first law is the foundation of modern physics. According to Mach's principle, Newton's first law exists thanks to stars and galaxies. Therefore, if you remove stars and galaxies, Newton's first law will cease to function. Therefore, the entire building of physical laws will collapse. This destruction of physical laws is expressed in equations (1) and (4).

When scientists at the beginning of the twentieth century discovered the uncertainty in the microcosm, they were greatly surprised. They were surprised at the disorder that was discovered in the microcosm. Scientists are accustomed to the global order that is observed in the Universe. They perceived this order as something natural, and disorder in the microcosm as something unnatural. From a new point of view, it is the opposite. Chaos exists from the beginning. And order from Chaos arises from the combined gravitational effects of all galaxies and stars. Uncertainty in the microcosm is the remainder of Chaos after imposing on it the gravitational influence of all the matter of the Universe. The Universe's mass is very large and that is why Chaos manifests itself mainly in the microcosm. Planck's constant is a measure of the presence of Chaos in our world. I propose to call the equation (4) the Chaos formula.

5 Quantum mechanism of gravity

The Chaos formula (4) allows us to give a simple and clear explanation of the mechanism of gravity. Suppose an elementary particle is localized in a neighborhood of point A. There is a probability that after some time it will be in the neighborhood of point B. There is also the probability of an inverse transition. If Planck's constant is the same at these points, then the probabilities of a direct and an inverse transition are equal. But if Planck's constant at point B is less, then the probability of the inverse transition will be less. As a result,

the particle starts moving from point A to point B. According to the new theory, gravity is a quantum effect: a large mass limits the uncertainty in the motion of a particle and as a result attracts it.

Many physicists have noted that the gravitational interaction is very weak. Richard Feynman called this phenomenon the second amazing fact of gravity. He was surprised that the force of the gravitational attraction between two electrons is less than the electric repulsion force between them in $4.17 \cdot 10^{42}$ times [6]. This is a very large number. Why is gravity so weak? Within the framework of the new theory, the answer is simple. The gravitational potential of the Universe $\Phi = -c^2 \approx -10^{17}\ m^2/s^2$ is determined mainly by distant galaxies. Therefore, the magnitude of Planck's constant is also determined mainly by distant galaxies. We take the differential of equation (4): $2hdh \cdot \Phi + h^2 d\Phi = 0 \Rightarrow$

$$\frac{dh}{h} = -\frac{d\Phi}{2\Phi} = \frac{d\Phi}{2c^2} \qquad (5)$$

Close-lying bodies give only a small contribution to the reduction of Planck's constant. Consequently, the relative decrease in Planck's constant is very small. Therefore, the force of gravitational attraction is weak. For example, the gravitational potential created by an electron at a distance of atomic size is approximately equal to $-10^{-30}\ m^2/s^2$. This is less than the potential of the Universe in about 10^{47} times. In the same proportion, there is a relative decrease in Planck's constant near the electron. Therefore, the force of gravity between electrons is so weak.

The quantum mechanism of gravity can be considered on the other hand. According to quantum mechanics, de Broglie wave is associated with each particle. When a particle moves near a large mass de Broglie wavelength decreases because of the decrease in Planck's constant. Any wave always turns to the direction where its wavelength is smaller. Therefore, the particle turns toward the large mass and is thus attracted to it. Equation of the trajectory of motion is presented in the monograph [11].

6 Einstein's formula: the equality of the inertial and gravitational masses

A number of interesting consequences follows from the Light formula (1). For example, according to relativity theory, the speed of light does not depend

on the motion of an observer and the light source. Why does the speed of light behave so strangely? This question is not answered by the theory of relativity. The independence of the speed of light is the basic postulate of relativity theory, which has no theoretical justification. The Light formula allows us to justify it. The speed of light is determined by the gravitational potential, but the magnitude of the potential does not depend on your movement. Therefore, speed of light also does not depend on your movement.

Another important question in relativity theory is related to Einstein's formula:

$$E = mc^2 \tag{6}$$

Why does any mass m have such a huge energy E? Relativity theory does not answer this question. Let us multiply the Light formula (1) by mass m:

$$mc^2 = -m\Phi \tag{7}$$

We see that any mass has energy because it is in the gravitational field of the Universe Φ. The total energy of a body is exactly equal to its energy of attraction to all the objects of the Universe. If there were no massive objects (galaxies and stars), test bodies would not have energy. The energy of a body E is enormous because the gravitational potential of the Universe Φ is enormous.

It follows from the Light formula that the total energy of any body (including rest energy) is exactly equal to its potential energy in the gravitational field of the Universe with a minus sign. If we completely transform a body into light (annihilation), then this energy will be enough for the light to reach the boundary of the Universe ($\Phi = 0$), where the light will stop ($c = 0$). Therefore, the total energy (rest energy and kinetic energy) of any body E is equal to its potential energy U with a minus sign:

$$E + U = 0 \tag{8}$$

It does not matter whether the body is at rest or moving at high speed. In any case, the total energy of the body is such that if the body is turned into light (annihilation), then this light will fly exactly to the boundary of the Universe and it will stop there.

In physics, two types of mass are distinguished, inertial and gravitational. The inertial mass is in Newton's second law. This mass is a measure of the inertia of the body. It shows how strongly the body resists acceleration. The

gravitational mass is in the Newton's law of universal gravitation. This mass is a measure of the ability of the body to participate in the gravitational interaction. The body weight is proportional to its gravitational mass. This mass plays the role of the gravitational charge of the body.

Thanks to numerous experiments it was established that the inertial and gravitational masses of any body are always equal with very high accuracy. Therefore, in modern physics it is generally accepted that the inertial and gravitational masses are exactly equal. Einstein used the equality of these masses as a foundation for building general relativity. But this equality has no theoretical justification. In the framework of modern physics, it is not known why the inertial mass of a body is always equal to its gravitational mass. Richard Feynman called this equality the first amazing fact of gravity [6].

The Light formula explains why the inertial and gravitational masses of any body are always equal. Let's look at equation (8). The total energy of the body E is determined only by its inert mass m_{in} and the speed of light c: $E = m_{in}c^2$. This equation is valid for a resting body and for a moving body. The moving body has more energy and inertial mass. The potential energy U of the body in the gravitational potential of the Universe Φ depends only on its gravitational mass m_{gr}: $U = -m_{gr}\Phi$. As a result, we get: $m_{in}c^2 + m_{gr}\Phi = 0$. Considering the Light formula we get: $m_{in} = m_{gr}$. We have proved the equality of the inertial and gravitational masses based on the Light formula.

7 Acceleration of light and potential energy

It is known that all bodies and all elementary particles, including antimatter, move in a gravitational field with the same acceleration. Einstein used this fact as the basis of general relativity. However, when the general relativity was constructed, it turned out that photons should move in the gravitational field not with acceleration, but with deceleration. According to general relativity, the radio signal slows down near the Sun. Does not it look strange? Einstein began with the fact that all the bodies are equally accelerated in a gravitational field. But then he concluded that photons slow down when they fall. Contrary to general relativity, we construct a theory in which photons are accelerated in a gravitational field. From the Light formula (1) it follows that light accelerates near the Sun, Earth and other massive objects. With what acceleration does light move in a gravitational field?

According to quantum mechanics, the behavior of all particles including photons is the same [9]. In addition, the substance can be converted into light, and light into a substance. If we take a weightless (very light) mirror sphere and fill it with light, then with what acceleration will this sphere fall? I suppose the sphere will fall with gravitational acceleration. Otherwise, turning light into the substance and back, we can change the acceleration of the fall of this sphere. Let us suppose that the light falls with gravitational acceleration and then we will see what conclusions will follow from such an assumption.

Let the photon move vertically down in the gravitational field g. The change in the photon's speed dc after the period of time dt is equal to $dc = gdt$. The passed path dx is equal to $dx = cdt$. Hence $dc = gdx/c$ or $cdc = gdx = -d\varphi$. Here $d\varphi$ is the change in the Newtonian potential. Taking the integral, we obtain:

$$\frac{1}{2}c^2 + \varphi = \text{const} \qquad (9)$$

When I first got this equation, I was very upset because equation (9) clearly contradicts the Light formula (1). For a long time I did not know what to do. I was absolutely sure of the truth of the Light formula. This is too simple and too beautiful a formula and, in my opinion, it must be true. Consequently, the light cannot fall with gravitational acceleration? I did not like this conclusion. Gradually, it was understood that both equations (1) and (9) could be correct. Let us assume that these equations are correct and we will find out what conclusions follow from this assumption. We can immediately write:

$$\Phi = 2\varphi \qquad (10)$$

The gravitational potential Φ in the new theory is exactly two times greater than the gravitational potential in Newton's theory. Why? Let us remember how the potential is calculated in Newton's theory. If a body of mass m falls from height x in the gravitational field g, then it performs the work mgx. The work done is equal to the change in the potential energy. Is it correctly? No, it is not right! We forgot to take into account the change in internal energy, which is equal to mc^2. The speed of light increases, so the rest energy of the body increases. This change needs to be taken into account. When the body falls, the potential energy is converted into the kinetic energy and the rest energy. We measure only the kinetic energy and make an incorrect conclusion

about the change in the potential energy. The potential energy is underestimated. In the new theory, the potential energy is exactly two times greater (10). When the body falls, only half of the potential energy goes to the kinetic energy, and the second half goes into the rest energy. For nonrelativistic bodies, the use of the Newtonian potential does not lead to an error since in this case only half of the potential energy is converted to the kinetic energy. But Newton's theory will lead to an error for relativistic bodies. For example, a photon does not have rest energy. Therefore, all of its potential energy is converted into kinetic energy. Consequently, the kinetic energy of the photon should increase two times faster than the energy of an ordinary body. So, the light moving near the Sun deviates by an angle of two times more than it follows from Newton's theory.

Below, we will describe what kind of experiment can be carried out in a modern physical laboratory to verify the validity of equation (10).

8 The law of conservation of mass and the defect of the rest mass

Let some object (solid, gas cloud, light, etc.) with full energy (including rest energy) E moves in a gravitational field. The inertial mass m_{in} of this object is equal to its gravitational mass m_{gr} and is equal to E/c^2. Based on the law of conservation of energy and applying the Light formula we can write:

$$dE = -m_{gr}d\Phi = -\frac{E}{c^2}d\Phi = \frac{E}{c^2}dc^2 = \frac{2cE}{c^2}dc = \frac{2E}{c}dc \Rightarrow$$

$$\int\frac{dE}{E} = \int\frac{2dc}{c} \quad \Rightarrow \ln E - 2\ln c = \ln\frac{E}{c^2} = \text{const} \Rightarrow$$

$$\frac{E}{c^2} = \text{const} \tag{11}$$

We got a very interesting result. When any object moves in a gravitational field, its inertial and gravitational masses (the ratio of the total energy to the speed of light squared) remain constant.

According to relativity theory, the inertial mass of a body depends on its rest mass m and speed V:

$$m_{in} = \frac{m}{\sqrt{1 - \frac{V^2}{c^2}}} \qquad (12)$$

For example, if a particle is accelerated by the action of electrical forces, then its energy, velocity, and inertial mass increase. However, if the particle accelerates under the influence of gravity, then its energy and velocity will increase, but the inert mass will remain (11). This is because the speed of light increases. Taking equation (12) into account we can conclude that the rest mass of a body m decreases, since the velocity of a body increases. Thus, it follows from the Light formula that the inertial (gravitational) mass of a body when moving in a gravitational field is preserved, and the rest mass varies depending on the gravitational potential. The deeper the potential, the less the rest mass of bodies, atoms, and elementary particles. In the case of gravitational interaction, a mass defect similar to that existing in an atomic nucleus should be observed.

Einstein paid attention to the mass defect in the gravitational field for the first time in 1912. Einstein concluded that the total mass of two gravitationally bound bodies is less than the sum of the masses of these same bodies, if they do not interact with each other. The magnitude of the effect is equal to the gravitational binding energy divided by the square of the speed of light [13]. Zel'dovich and Novikov had written a whole paragraph about this defect in their monograph [14]. Nevertheless, in modern physics there is no formula about the connection between the rest mass and the gravitational potential. Now we will get such a formula.

As we found out, when a nonrelativistic body moves in a gravitational field, only half of the potential energy is converted into the kinetic energy, and the second half is converted into the rest energy: $dmc^2 = -\,{}^1/_2 md\Phi = {}^1/_2 mdc^2 = mcdc$. Hence $c^2dm + 2mcdc = mcdc \Rightarrow c^2dm = -\,mcdc \Rightarrow$

$$\int\frac{dm}{m} = -\int\frac{dc}{c} \quad \Rightarrow \quad \ln m + \ln c = \ln mc = \text{const} \quad \Rightarrow$$

$$mc = \text{const} \quad \Rightarrow \qquad (13)$$

$$m^2\Phi = \text{const} \qquad (14)$$

The rest mass of bodies, atoms, and elementary particles varies in the gravitational field inversely proportional to the magnitude of the speed of light (13) and depends on the potential in the same way as Planck's constant (4). It follows from equation (14) that when approaching the boundary of the Universe ($\Phi \to 0$), the mass of an elementary particle increases without limit. What is the point of this? A particle will be able to reach the boundary of the Universe when it receives almost the speed of light. To do this, we should to give a huge energy to it and together with energy we will give the particle a huge mass. When the particle stops near the boundary of the Universe, it will lose its energy, but its huge mass will be completely preserved (11). The meaning of equation (14) is that no body and no particle can fly to the boundary of the Universe, since it will require an infinite energy and, consequently, an infinite mass.

Now we have all three formulas for the speed of light (1) Planck's constant (4) and the mass of an elementary particle (14). This is enough to perform all calculations in a gravitational field and obtain all the equations of motion for ordinary and relativistic bodies [11].

9 Atom in a gravitational field

According to general relativity, the spacetime scale changes in a gravitational field. That is, the unit of length and the unit of time change in a gravitational field. In modern physics, the unit of time is proportional to the period of a certain atomic radiation and the unit of length is proportional to the wavelength of the atomic radiation. Thus, the units of length and time are based on atomic radiation. Therefore, in order to understand the meaning of changing the spacetime scale, we need to answer a simple question. What happens to an atom in a gravitational field? How do its size, frequency of radiation, energy levels, and other characteristics change? We can easily answer all these questions using equations (1), (4) and (14), and also assuming that the electron charge, the fine structure constant and other dimensionless constants do not change in a gravitational field.

We have two ways to solve the problem. First, we can perform calculations using dimensional analysis of physical quantities. Secondly, we

can use the equations of quantum mechanics. Both ways should lead to the same result.

We will calculate the change in the atomic size a. Any size is proportional to h/mc. Taking (13) into account, we obtain $a \propto h$. On the other hand, according to formula for the Bohr radius, the radius of the hydrogen atom is proportional to h^2/m [15]. Taking (4) and (14) into account we obtain $a \propto h$. Both approaches give the same result: the size of an atom a depends on the gravitational potential as well as Planck's constant:

$$a \propto h \propto \frac{1}{c} \propto \frac{1}{\sqrt{-\Phi}} \tag{15}$$

Thus, the size of an atom decreases in a gravitational field. The closer an atom is to the Earth, the Sun or another massive object, the smaller its size.

We will calculate the energy difference ΔE between the energy levels in an atom. Based on the dimensional analysis of energy we can conclude that the energy varies in proportion to mc^2. Taking (13) into account we obtain $\Delta E \propto c$. On the other hand, according to quantum mechanics, $\Delta E \propto m/h^2$ [15]. Taking into account (4) and (14) we obtain $\Delta E \propto 1/h$. Taking into account (1) and (4) we obtain $\Delta E \propto c$. Both approaches give the same result. The distance between the energy levels of the atom varies in a gravitational field in proportion to the speed of light or inversely proportional to Planck's constant:

$$\Delta E \propto c \propto \frac{1}{h} \propto \sqrt{-\Phi} \tag{16}$$

The energy of a photon emitted by an atom is ΔE. The deeper the atom is located in the gravitational field, the greater the energy emitted by the photon. According to general relativity, it is on the contrary.

We will calculate the change in the frequency of the atomic radiation ω. Based on the dimensional analysis of frequency we can conclude that the frequency of atomic radiation varies in proportion to mc^2/h. Taking (4) and (14) into account we obtain $\omega \propto c^2$. On the other hand, according to quantum mechanics, the frequency of emission of a hydrogen atom is proportional to m/h^3 [15]. Taking (4) and (14) into account we obtain $\omega \propto 1/h^2$. Taking (1) and (4) into account we obtain $\omega \propto c^2$. Both approaches give the same result: the frequency of atomic radiation changes in a gravitational field in proportion to

light speed squared, that is, directly proportional to the gravitational potential of the Universe Φ:

$$\omega \propto c^2 \propto \hat{O} \tag{17}$$

The deeper the atom is in the gravitational field, the higher its frequency of radiation. This clearly contradicts the general relativity.

We have identified several contradictions between the new theory of gravity and general relativity. Now we will consider an experiment that will determine which of the two theories is wrong.

10 The decisive experiment with atomic clocks

According to general relativity, the frequency of atomic radiation ω decreases in the gravitational field g. If one atom is located on the surface of the Earth, and the other one is at a height H, then the frequency of the lower atom will be lower:

$$\frac{\Delta\omega}{\omega} = -\frac{gH}{c^2} \tag{18}$$

According to the new theory, the frequency of the lower atom will be higher (17):

$$\frac{\Delta\omega}{\omega} = \frac{|\Delta\Phi|}{c^2} = \frac{2gH}{c^2} \tag{19}$$

That is, the effect is two times larger and has a different sign. In the new theory, the rate of atomic clocks does not decrease, but increases near the Earth and other massive objects, contrary to general relativity. This effect can be checked in an experiment.

For the experiment, two high-precision atomic clocks with a relative error of 10^{-15} are required. First clock is installed on the first floor of a high-rise building, and second clock is set on the top floor. The height difference should be 100 meters or more, so that the expected effect would exceed 10^{-14}. If H = 100 m, then according to general relativity, the lower clock should run more slowly. This effect is about 1 ns for every day. According to the new theory of gravity, the lower clock should run faster. The new effect is about 2 ns per day.

Comparing the readings of the clocks during 2-3 weeks, it will be possible to find out which of the two theories of gravitation is wrong.

Have not experiments with atomic clocks been conducted many times? Many specialists in general relativity claim that the time dilation near the Earth is a firmly established experimental fact [7]. I also adhered to this point of view until I studied the experiments more carefully. The essence of all these experiments is in the following. An experimenter compares the frequencies of two atomic clocks. When the clocks are at the same height, then their frequencies are equal. Then the experimenter raises one clock up and detect that the frequency of the lower clock is lower. He concludes from this that the frequency of the lower clock is lower. Is it logical? Not really.

Here is an explanation of this experiment and similar experiments in the new theory. The frequency of the lower clock is higher than the upper ones by a relative value $2gH/c^2$ (19). When a signal from them goes up, its energy decreases by a relative value $2gH/c^2$, since an electromagnetic wave moves in the field of the double potential (10). The signal frequency decreases by a relative value $3gH/c^2$, due to the growth of Planck's constant (5). As a result, the signal comes up reddened with a relative value gH/c^2. All these calculations are performed in [11]. It is incorrect to compare frequencies of atomic clocks, since a signal moves in a gravitational field and its frequency varies. To exclude the influence of gravity on a frequency of a signal while its movement, it is necessary to compare not the frequencies, but the readings of clocks. This experiment was not carried out.

It should be emphasized that a number of specialists in general relativity also believe that all experiments on measuring the gravitational frequency shift including the operation of GPS can be interpreted in different ways. Therefore, they propose to conduct an experiment with atomic clocks, similar to that I have been suggesting ([16], [17], [18]).

11 Conclusion

We built the new theory of gravity based on Mach's principle. From the new point of view, the fundamental constants (speed of light, Planck's constant, electron mass) depend on the distribution of all the matter in the Universe and vary depending on the magnitude of the gravitational potential. When you rise above the Earth's surface, the speed of light decreases, Planck's constant increases, and the masses of elementary particles increase. The relative effect

of these changes is of the order 10^{-14} per every 100 m. These changes in fundamental constants can be detected using modern high-precision metrological equipment.

From the new point of view, the spacetime in which we live exists only within the Universe due to the huge masses filling the Universe. As we approach the boundary of the Universe, the laws of motion degenerate ($c \to 0$, $h \to \infty$), and spacetime degenerates into Chaos. Usually Mach's principle is given the following meaning. If you move away from all large masses, the inertia of test bodies tends to zero [12]. We have given the new interpretation for Mach's principle. If you move away from all large masses, the uncertainty in the motion of test bodies increases without limit.

In the new theory, a quantum mechanism of gravitation is proposed. A large mass limits the uncertainty in the motion of a test body and as a result attracts it. In the new theory, Einstein's formula for the connection of mass and energy is theoretically justified, and the equality of the inertial and gravitational masses is also theoretically justified.

The new theory of gravitation radically contradicts general relativity. According to general relativity, the speed of light slows down near the Sun and other massive objects. According to the new theory, the speed of light increases near massive objects. According to general relativity, the frequency and energy of a photon remain constant, if it flies out from a gravitational field [16]. According to the new theory, if a photon flies out from a gravitational field, its energy decreases by half as fast as the energy of a usual body. And the photon frequency decreases faster than its energy due to the growth of Planck's constant. According to general relativity, the frequency of atomic radiation decreases near the Earth and other massive objects. According to the new theory, the atomic frequency, on the contrary, increases and the effect is two times greater than in general relativity.

If we conduct the experiment with atomic clocks located on the lower and upper floors of a high-rise building, then we can determine, which of the two theories of gravitation is wrong. It is necessary to emphasize that in such an experiment it is necessary to compare not the frequencies of atomic clocks (this comparison is incorrect, since the signal frequency changes when moving up or down), but the readings of atomic clocks for a long time using the cumulative effect.

The author hopes that this publication will attract specialists on precision metrology to conduct the experiment with atomic clocks. If it is confirmed that the atomic clock near the Earth will go faster, according to equation (19), this will radically change our knowledge of the Universe. General relativity will be refuted. Many theories of strings and superstrings based on general relativity will be disproved. It will become clear to everyone that black holes do not exist, since physical processes including propagation of light do not slow down, but on the contrary accelerate near massive objects. It will be proved that the gravitational potential is twice as large as in Newton's theory. It will be proved that Planck's constant decreases near massive objects, since the frequency of atomic radiation is inversely proportional to Planck's constant in the third degree. Thus, the quantum mechanism of gravitation will be confirmed. It will be proved that our Universe is surrounded by Chaos, when approaching it the light stops and Planck's constant increases indefinitely. Mach's principle in its new interpretation will be confirmed. Modern theories of star formation and the origin of galaxies will be revised, since these theories are based on general relativity.

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ACCURATE MASS FORMULAS AND PREDICTION OF MASSES ON HEAVY FLAVOR HADRONS

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Abstract

Based on the emergence string and other mechanism, we may derive the GMO mass formula and its modified accurately form $M = M_0 + AS + B[I(I+1) - S^2/2]$. According to the symmetry of s-c quarks, the heavy flavor hadrons which made of u, d and c quarks may be classified by SU(3) octet and decuplet, and some simple mass formulas are obtained, then m(Ξ_{cc})=3715 or 3673*MeV* are predicted. In July 2017 LHC observed a new and very charming baryon $\Xi_{cc}^{++} = ucc$, whose mass is 3621*Mev*. It agrees more on new formula, whose error only is 1.4%. Further, we predict m(Ω_{cc}^{+})=3946, or 3950.8, or 3908.2*MeV*, etc. Moreover, this method may be extended to other heavy flavor hadrons, and predict $m(\Xi_{bb})$=10396.8 or 10348.9*MeV*, etc. It is a quantitative and testable theory.

Key words: hadron, mass formula, string, heavy flavor.

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1. Introduction

It is very successful that the SU(3) symmetry and its broken are applied to the classification of the ground hadrons, which made of u, d and s quarks, and to the mass spectrum, etc. It is also well known that those hadrons agree with the Gell-Mann-Okubo (GMO) mass formula:

$$M = M_0 + AS + B[I(I+1) - \frac{S^2}{4})]. \tag{1}$$

Here must assume that $M = m^2$ for mesons. Recently, Koschmieder discussed the status of particle theory, and investigated the masses of the elementary particles [1]. In this paper, we discuss the modified accurate mass formulas, and from which predict the masses of some heavy flavor hadrons.

Recently, Gorbunov and Tokareva shown a framework of high energy scale invariance can explain the origin of dark radiation [8]. Pérez-García and Silk discussed constraining decaying dark matter with neutron stars [9]. Miranda, et al.,

2. Emergence String and Accurate Mass Formulas of Hadrons

By different ways [2-5], we derived the GMO mass formula (1) and its modified accurate mass formula:

$$M = M_0 + AS + B[I(I+1) - \frac{S^2}{2})]. \tag{2}$$

Simultaneously, we obtained the corresponding symmetric lifetime formulas of hadrons [3-5].

Using Eq.(2), for the $J^p = 1^+/2$ baryon octet, let M_0 =910.75MeV, A=–222.04MeV and B≈38.43MeV, so

$$\begin{aligned} &m(n) = 939.5725, m(\Lambda) = 1115.6MeV, \\ &m(\Sigma^0) = 1192.46, m(\Xi^0) = 1314.89MeV. \end{aligned} \tag{3}$$

Therefore, Eq.(2) agrees completely with the experimental data of the neutral baryons [6].

For the $J^{pc} = 0^{-+}$ meson octet, let A=0, M_0 =549.4MeV and B= –207.22MeV, so

$$m(\pi^0) = 134.96, m(K^0) = 497.6, m(\eta) = 549.4\,MeV, \tag{4}$$

the neutral mesons agree completely within the range of error [6], and baryon and meson can be unified by M=m.

For the $J^p = 3^+/2$ baryon decuplet I=1+(B+S)/2 always holds, so the formula (2) just derives a more accurate formula

$$M = (M_0 + \frac{15}{4}B) - (A - 2B)S - \frac{B}{4}S^2 = M_0' - aS + bS^2. \tag{5}$$

Let M_0'=1231.8, a=156.8 and b= –3.3MeV, so

$$m(\Delta) = 1231.8, m(\Sigma) = 1385.3, m(\Xi) = 1532.2, m(\Omega) = 1672.5\,MeV. \tag{6}$$

The mass relations

$$2(N + \Xi) = 3\Lambda + \Sigma, \tag{7}$$

$$4(N + \Xi) = 7\Lambda + \Sigma, \tag{8}$$

correspond to Eqs.(1) and (2), respectively.

Based on the known theories [7,8], the mass operator of the first broken SU(3) symmetry is [7]:

$$O_M = H_{VSI} + H_{MSI} = M_0 + AU_3 = M + AS + BI(I+1) + CS^2. \tag{9}$$

For the famous mass relation (1), C= –B/4 is obtained. For a new mass relation (2) which agrees better with the data, we may obtain C= –B/2 and Eq.(2). In Ref.[8], the mass of the same multiplet can be split into irreducible parts according to the Clebsch-Gordan series

$$8 \otimes 8 = 1 \oplus 8' \oplus 8'' \oplus 10 \oplus \overline{10} \oplus 27. \tag{10}$$

Neutrality means that 10 and $\overline{10}$ are absent, then

$$m_N = (m_1 - 2m'_8 + m''_8 - 3m_{27}), m_\Lambda = (m_1 - m'_8 - m''_8 + 9m_{27}), \quad (11)$$

$$m_\Sigma = (m_1 + m'_8 + m''_8 + m_{27}), m_\Xi = (m_1 + m'_8 - 2m''_8 - 3m_{27}). \quad (12)$$

"Suppose that the mass splitting is generated in a more fundamental Lagrangian by a quark-mass term of the type $\overline{\psi}(a + b\lambda_8)\psi$ carrying only singlet and octet representations and that this property is (miraculously) preserved by the interactions. This would mean that m_{27} vanishes," leading to Eq.(1). If we let $m_{27} = (m'_8 + m''_8)/44 \neq 0$, Eq.(2) will be derived.

Further, we research possible mechanism of formulas (1) and (2), which include that I(I+1) corresponds to rotation, and S and S^2 corresponds to oscillation, in particular, for anharmonicity. Assume that hadrons are formed from the emergence string [5]. Usual string should possess two moving states: oscillation and rotation, based on the general oscillation and rotation of string we propose that a corresponding equation of the emergence string may be

$$\frac{d^2\psi}{dr^2} + [-\frac{K(K+1)}{r^2} + 2m(E-U)]\psi = 0. \quad (13)$$

This equation may regard one of a scalar field in the gauge theory derived from emergence string [9]. Moreover, if U is a potential of the anharmonic oscillator [10,11]:

$$U(r) = \frac{1}{2}m\omega^2 r^2 + \alpha r^3. \quad (14)$$

Bolokhov, et al., described the heterotic string solutions in the M model, which obtained in U(N) gauge theories for N=2 supersymmetric QCD deformed by superpotential terms μA^2 breaking [12]. Polyakov constructed vertex operators for massless higher spin fields in Ramond-Neveu-Schwarz superstring theory, and derived the gauge-invariant cubic interaction terms for the higher spins [13].

Such a corresponding energy level for Eq.(13), in second approximation, is:

$$E_{k,n} = E_{0,0} + \hbar\omega(n+\frac{1}{2}) + \frac{\hbar^2}{2mr_0^2}K(K+1) - \frac{\hbar^2\alpha^2}{8m^3\omega^4}(30n^2+30n+11). \quad (15)$$

If oscillation and rotation of the emergence string correspond respectively to quantum numbers S(Y) and I, this energy level will correspond completely to the mass formula of hadrons:

$$M = M_0 + AS + BI(I+1) + CS^2. \quad (16)$$

When $C=-B/4$, it is the GMO mass formula (1). When $C=-B/2$, it is a modified accurate mass formula (2)[2-5]. Such not only baryons and mesons are unified M=m, and Eq.(2) agrees accurately with the experiments. These are some relations between the string and observable experimental data.

Further, any model with general oscillation and rotation may obtain the Morse potential [14] and corresponding energy level.

3. Heavy Flavor Hadrons and Their Masses

In the standard model quarks are the three generations (u,d) (c,s) and (t,b), whose properties exhibit a better symmetry. Some hadrons including heavy flavor c, b and t quarks have been found, and they are consistent with the SU(N) multiplets. Based on the symmetry of s and c quarks in the same generation, we supposed that the hadrons, which made of u, d and c quarks, are also the SU(3) symmetry and are classified by octet and decuplet [15,4,5]. It is a subgroup of SU(4) of u, d, s and c quarks. Such the eight $J^P = 1^+/2$ baryons form also an octet:

p=uud, n=udd(I=1/2);

$$\Lambda_c^+ = udc(I=0); \Sigma_c^{++} = uuc, \Sigma_c^+ = udc, \Sigma_c^0 = ddc(I=1);$$

and $\Xi_{cc}^{++} = ucc, \Xi_{cc}^+ = dcc(I=1/2)$.

Such we assume that these masses of the octet obey the corresponding simple mass formulas only by S→C in Eqs.(1) and (2):

$$M = M_0 + AC + B[I(I+1) - (C^2/4)], \quad (17)$$

or $$M = M_0 + AC + B[I(I+1) - (C^2/2)]. \quad (18)$$

Since m(N)=939, $m(\Lambda_c^+) = 2285, m(\Sigma_c) = 2453\,MeV$ [6], from the two corresponding mass formulas (7) and (8) we predicted $m(\Xi_{cc}) = 3715$ or $3673MeV$ [15,4,5]. In 10 July 2017 LHC announced to observe a new and very charming baryon $\Xi_{cc}^{++} = ucc$, whose mass is 3621.40±0.72(stat.)±0.27(syst.)MeV, and decay mode is $\Xi_{cc}^{++} \to \Lambda_c^+ K^- \pi^+ \pi^+$ [16]. New experimental data agree more on Eq.(8) and (2), whose error only is (3673–3621)/3621=1.4%. Moreover, there should have $\Xi_{cc}^{+} = dcc$, both form I=1/2 doublet with near mass, and one of decay modes is $\Xi_{cc}^{+} \to \Lambda_c^+ K^- \pi^+ \pi^0$ [17]. In 1994 we predicted that "if the experiments derive this mass, it will show that our theory (hadrons made of u, d and c quarks are the SU(3) symmetry) is right"[15].

According new experimental data [6], let M_0=877.2, A=1450.9, B=83.2MeV in (18), we derive m(n)=939.6, $m(\Lambda_c^+) = 2286.5$, $m(\Sigma_c^+) = 2452.9\,MeV$ and $m(\Xi_{cc}) = 3675MeV$.

For the $J^p = 3^+/2$ baryons, $\Delta^{++}, \Delta^+, \Delta^0, \Delta^-$ (I=3/2); $\Sigma_c^{++}, \Sigma_c^+, \Sigma_c^0$ (I=1); $\Xi_{cc}^{++}, \Xi_{cc}^+$ (I=1/2) and $\Omega_{ccc}^{++} = ccc$ (I=0) form also a decuplet. Their masses are possibly an equal-spacing rule, i.e.

$$M = M_0 + aC. \tag{19}$$

Of course, these baryons obey probably the more accurate mass formulas

$$M = M_0 + aC + bC^2, M = M_0 + a'I + b'I^2, \tag{20}$$

which correspond to Eqs.(2) and (5).

The $J^p = 0^-$ octet of heavy flavor mesons are:

$\pi^{+,-},\pi^0(I=1); D^+ = c\bar{d}, D^0 = c\bar{u}(I=1/2)$ and their antiparticles; $\eta'_c = a(u\bar{u}+d\bar{d}) + b(c\bar{c})$. If their mass relation is:

$$4m(D)= m(\pi) + 3m(\eta'_c) \text{ or } 8m(D)= m(\pi) + 7m(\eta'_c), \qquad (21)$$

so $m(\eta'_c)$ =2444 or 2114MeV since m(π)=137, m(D) =1867MeV. For the $J^p = 1^-$ octet, $m(\rho) = 770, m(D^+) = 2010$ MeV, so $m(\eta'_c)$ =2423 or 2187MeV.

For the $J^p = 1^+/2$ baryons,

m($\Xi_c^+(usc)$)=2467.8MeV, m($\Xi_c^0(dsc)$)=2470.9MeV (I=1/2),

m($\Omega_c(ssc)$)=2695.2MeV.

These octets and decuplet are a certain cross section of the diagrams of the SU(4) multiplets, respectively. For the $J^p = 3^+/2$ baryons, probably, the masses of the triplet $\Sigma^+,\Sigma^0,\Sigma^-$ (I=1), the doublet $\Xi_c^+(usc), \Xi_c^0(dsc)$ (I=1/2), and the singlet $\Omega_{cc}^+ = scc$ (I=0) are approximately an equal-spacing rule, it is the second series of series of heavy flavor baryons. Then the masses of $\Omega^- = sss$, $\Omega_c^0 = ssc, \Omega_{cc}^+$ and Ω_{ccc}^{++} are only four hadrons for mixtures of second generation, and their masses are should be equal-spacing too. It is the third series of heavy flavor baryons. For the $J^p = 3^+/2$ baryons, m(Σ_c)=2518, m(Ξ_c)=2646, m($\Omega_c(ssc)$)=2766MeV, these masses obey equal-spacing rule. Such based on the known masses of $3^+/2$ baryons including c quark [6], other masses of baryons will be able to be estimated.

Because Σ_c(uuc,2518)$-\Delta$(uuu,1232)=1286≅m(c)-m(u), so m(Ξ_{cc})=3804 and m(Ω^{++}_{ccc})=5090. From the third series, we obtain m(Ω^-)=1675.4, m(Ω^0_c)=2811.6, m(Ω^+_{cc})=3950.8 and m(Ω^{++}_{ccc})=5090. But, from the second series the known m(Σ)=1385 and. m(Ξ_c)=2646.6, so c-u≅1261.6 and m(Ω^+_{cc})=3908.2. Both m(Ω^+_{cc}) are different due to different of spin. Of course, these baryons obey probably the more accurate mass formulas (20).

Such any one of masses of $3^+/2$ baryons including c quark is known again, for example, for $\Sigma^0_c(2517.5\pm1.4)MeV$ ($J^p=3^+/2$) [18], then other five masses of other baryons will be able to be estimated.

baryon	Ω^-	Ξ_c	Δ	Σ_c	Ξ_{cc}	Ω_c	Ω^+_{cc}	Ω^{+++}_{ccc}
m(exp)	1672	2644	1231	2516				
m(*est*)	*input*	2666	*input*	*input*	3800	2809	3946	5084

Therefore, by using different ways we predict different m(Ω^+_{cc})=3946, or 3950.8, or 3908.2*MeV*, etc.

For the doublet $\Xi^+_c = usc, \Xi^0_c = dsc$ (I=1/2, S= –1, C=1) and both masses are 2467.9 and 2471.0*MeV*, the singlet $\Omega^0_c = ssc$ (I=0, S= –2, C=1) and its mass is 2697.5±2.6*MeV*, and the singlet $\Omega^+_{cc} = scc$ (I=0, S= –1, C=2), we can assume that the simplest mass formula is:

$$M = M_0 + A(C-S) + B[I(I+1) - (C-S)^2/2], \tag{22}$$

or

$$M = M_0 + A(C-S) + B[I(I+1) - (C^2+S^2)/2]. \tag{23}$$

Some similar multiplets and mass formulas exist possibly in baryons and mesons including b or t quarks. For instance, both mass spectra of $\psi = c\bar{c}$ and $\gamma = b\bar{b}$ are similar; as in the neutral kaon system, $D^0 - \overline{D^0}$ and $B^0 - \overline{B^0}$ mixings should exist.

Further, this method will be able to be extended to other potentials and other heavy flavor hadrons. For example, based on the symmetry of quarks model, we may suppose that the hadrons, which made of u, d and b quarks, and of u, d and t all are the SU(3) symmetry. It is a subgroup of SU(4) of u, d, b and t quarks. Such the eight $J^p = 1^+ / 2$ baryons form also an octet:

p=uud, n=udd(I=1/2); $\Lambda_b^0 = udb(I = 0)$;

$\Sigma_b^+ = uub, \Sigma_b^0 = udb, \Sigma_b^- = ddb(I = 1)$;

and $\Xi_b^0 = ubb, \Xi_b^- = dbb(I = 1/2)$.

Such the corresponding mass formulas are:

$$M = M_0 + aB + b[I(I+1) - (B^2/4)], \tag{24}$$

or $$M = M_0 + aB + b[I(I+1) - (B^2/2)]. \tag{25}$$

It is known the m(Λ_b)=5620, m(Σ_b)=5811.5(5807.8, 5815.2)MeV [6]. From the two corresponding mass formulas, we may predict $m(\Xi_{bb})$ =10396.8 or 10348.9MeV, whose error is probably bigger due to weaker symmetry between first (u,d) and third generations (t,b).

Generally, based on the symmetry of quark model we can suppose that the hadrons, which made of s, c and b quarks are the SU(3) symmetry. Similar, the hadrons made of s, c and t quark are also the SU(3) symmetry. Both are two subgroups of SU(4) of s, c, b and t quarks, but these quarks are all I=0 and very unstable. These mass formulas are possibly:

$$M = M_0 + aS + a'C + a''B + bS^2 + b'C^2 + b''B^2, \tag{26}$$

or $$M = M_0 + aS + a'C + a''B + b(S + C + B)^2. \tag{27}$$

The mixtures of three generations are:

m($\Xi_b^0 = usb, \Xi_b^- = dsb$)=5790.5$MeV$(I=1/2).

Other hadrons are m($\Lambda_b^0(udb)$)=5620.2MeV, m(Ω_b^- (ssb))=6071MeV, etc.

In a word, our research based some symmetries among different generations is a quantitative and testable theory.

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INSUFFICIENCES OF GENERAL RELATIVITY

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Abstract

By using space-time rings, we establish a new mathematical theory of space-time with the coexistence of subluminal and superluminal speeds [1,12]. By using a new method, we derive a new gravitational theory without the equivalence principle in which tardyonic rotational motion produces a centrifugal force, while tachyonic rotational motion produces a centripetal force, which is here identified as gravity. We derive a new cosmological model without dark matter, dark energy, and gravitational waves. The theory of everything results to have two forces, the subluminal force (electromagnetism and weak force), and superluminal force (gravity and strong force).

Keywords: new gravitational formula, expansion theory of universe.

PACS: 04.90.+e,98.80.-k.

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1. Mathematical Theory of Space-Time With SASC

Throughout history, the notion of space and time has undergone a number of dramatic transformations, thanks to figures ranging from Aristotle, Leibniz and Newton to Gauss, Poincare and Einstein. In the present understanding of nature, space and time form a single entity called space-time. In 1975 Jiang has established the mathematical theory of space-time with SASC. This theory plays a key role for the entire field of physics to unlock the deepest mysteries of the universe.

In the Universe there are two matters: (1) observable subluminal matter called tardyon (locality) and (2) unobservable superluminal matter called tachyon (non-locality) which coexist in motion. Tachyon can be converted into tardyon, and *vice versa*. Tardyonic rotating motion produces the centrifugal force, but tachyonic rotating motion produces the centripetal force, that is gravity. Using tardyonic and tachyonic coexistence principle we deduce the new gravitational formula,

For establishing the mathematical theory of space-time with SASC. we first define space-time ring [1,9-10]

$$Z = \begin{pmatrix} ct & x \\ x & ct \end{pmatrix} = ct + jx, \qquad (1)$$

where x and t are the tardyonic space and time coordinates, c is light velocity in vacuum, $j = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$.

(1) can be written as Euler form

$$Z = ct_0 e^{j\theta} = ct_0(\mathrm{ch}\,\theta + j\,\mathrm{sh}\,\theta), \qquad (2)$$

where ct_0 is the tardyonic invariance, θ tardyonic hyperbolical angle.

From (1) and (2) we have

$$ct = ct_0\,\mathrm{ch}\,\theta, \quad x = ct_0\,\mathrm{sh}\,\theta \qquad (3)$$

$$ct_0 = \sqrt{(ct)^2 - x^2}. \qquad (4)$$

From (3) we have

$$\theta = \mathrm{th}^{-1}\frac{x}{ct} = \mathrm{th}^{-1}\frac{u}{c}. \qquad (5)$$

where $c \geq u$ is the tardyonic velocity.
Using the morphism $j: z \to jz$, we have

$$jz = \bar{x} + j\bar{t} = \bar{x}_0 e^{j\bar{\theta}} = \bar{x}_0(\mathrm{ch}\,\bar{\theta} + j\,\mathrm{sh}\,\bar{\theta}), \qquad (6)$$

where $\bar{x}$ and $\bar{t}$ are the tachyonic space and time coordinates, $\bar{x}_0$ is tachyonic invariance, $\bar{\theta}$ tachyonic hyperbolical angle.

From (6) we have

$$\bar{x} = \bar{x}_0 \,\mathrm{ch}\,\bar{\theta}, \quad c\bar{t} = \bar{x}_0 \,\mathrm{sh}\,\bar{\theta}. \qquad (7)$$

$$\bar{x}_0 = \sqrt{(\bar{x})^2 - (c\bar{t})^2}\,. \qquad (8)$$

From (7) we have

$$\bar{\theta} = \mathrm{th}^{-1}\frac{c\bar{t}}{\bar{x}} = \mathrm{th}^{-1}\frac{c}{\bar{u}}. \qquad (9)$$

where $\bar{u} \geq c$ is the tachyonic velocity.

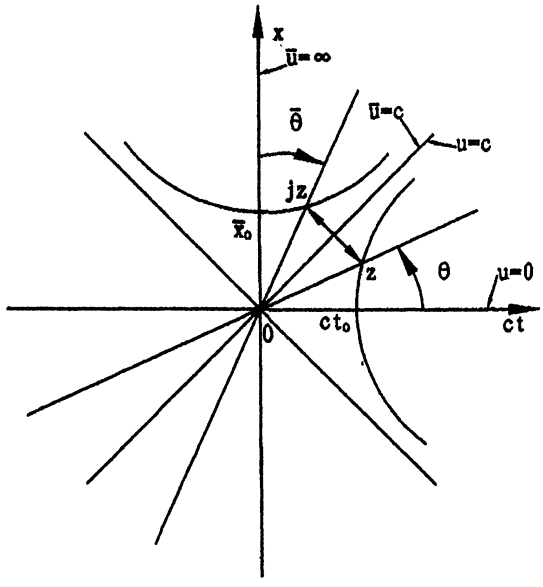

Fig. 1. Mathematical theory of space-time with SASC

Figure 1 shows the formulas (1)-(9). $j: z \to jz$ is that tardyon can be converted into tachyon, but $j: jz \to z$ is that tachyon can be converted into

tardyon. $u = 0 \to u = c$ is the positive acceleration, but $\bar{u} = \infty \to \bar{u} = c$ is the negative acceleration, which coexist. At the ct-axis u=0 and x=0 we define the tardyonic rest time t. At the x – axis we define the tachyonic rest space

$$\bar{X}_0 = \lim_{\substack{\bar{u}\to\infty \\ t\to 0}} \bar{u}t = \text{constant}. \qquad (10)$$

Since at rest the tachyonic rest time $t = 0$ and $\bar{u} = \infty$, we prove that tachyon is unobservable.

Fig.1 and (10) are mathematical theory of space-time with SASC, which are the foundations of physics and cosmology. Using it we prove that dark matter, dark energy, gravitational waves, quantum entanglements, quantum computers and black holes do not exist. From Fig.1 we deduce new gravitational formula.

2. New Gravitational Formula: $\bar{F} = -\frac{mc^2}{R}$ without dark matter

Assume $\theta = \bar{\theta}$, from (5) and (9) it follows SASC [1,4-6,9-10]

$$u\bar{u} = c^2. \qquad (11)$$

Using the analytical method, we deduce the new gravitational formula. Differentiating (11) by the time, we get

$$\frac{d\bar{u}}{dt} = -\left(\frac{c}{u}\right)^2 \frac{du}{dt}. \qquad (12)$$

$\frac{du}{dt}$ and $\frac{d\bar{u}}{dt}$ can coexist in motion, but their directions are opposite.

We study the tardyonic and tachyonic rotating motions. In 1673 Huygens discovered that the tardyonic rotation produces centripetal acceleration

$$\frac{du}{dt} = \frac{u^2}{R}, \qquad (13)$$

where R is rotating radius.

Substituting (13) into (12) we have the tachyonic centrifugal acceleration

$$\frac{d\bar{u}}{dt} = -\frac{c^2}{R}. \qquad (14)$$

(13) and (14) have the same form. From (13) we get the tardyonic centrifugal force

$$F = \frac{Mu^2}{R}, \qquad (15)$$

where M is the inertial mass.

From (14) we get the tachyonic centripetal force, that is gravity

$$\overline{F} = -\frac{mc^2}{R}, \qquad (16)$$

where m is the gravitational mass converted into by tachyonic mass $\overline{m}$.

(15) and (16) have the same form. (16) is the new gravitational formula.

Using the geometrical method, we deduce the new gravitational formula.

Figure 2 shows that the rotation ω of body A emits tachyon mass $\overline{m}$, which forms the tachyon and gravitation field and gives the body B revolutions u and $\overline{u}$.

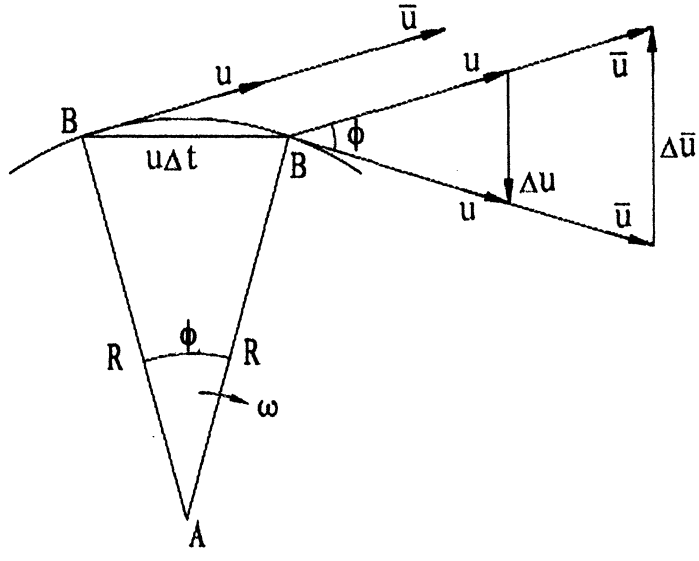

Fig.2. On body B the $\frac{du}{dt}$ and $\frac{d\overline{u}}{dt}$ coexistence [4]

From Fig. 2. it follows

$$\frac{u\Delta t}{R} = \frac{\Delta u}{u}. \qquad (17)$$

From (17) it follows the tardyon centripetal acceleration on the body B [4-6],

$$\frac{du}{dt} = \lim_{\substack{\Delta u \to 0 \\ \Delta t \to 0}} \frac{\Delta u}{\Delta t} = \frac{u^2}{R}. \qquad (18)$$

From Fig. 2. it follows

$$\frac{u\Delta t}{R} = -\frac{\Delta \bar{u}}{\bar{u}}. \qquad (19)$$

From (19) and (11) it follows the tachyon centrifugal acceleration on the body B [4-6],

$$\frac{d\bar{u}}{dt} = \lim_{\substack{\Delta \bar{u} \to 0 \\ \Delta t \to 0}} \frac{\Delta \bar{u}}{\Delta t} = -\frac{u\bar{u}}{R} = -\frac{c^2}{R}. \qquad (20)$$

On body B the $\frac{du}{dt}$ and $\frac{d\bar{u}}{dt}$ coexistence.

From (18) it follows the tardyon centrifugal force on body B [4-6],

$$F = \frac{M_B u^2}{R}, \qquad (21)$$

where M_B is body B inertial mass.

From (20) it follows the tachyon centripetal force on body B, that is gravity [4-6,9-10],

$$\bar{F} = -\frac{mc^2}{R}, \qquad (22)$$

where m is the gravitation mass converted into by tachyon mass $\bar{m}$ which is unobservable, but m is observable.

(22) is the new gravitational formula. In 1976[4] this simple thought made a deep impression on me. It impelled me to establish the new gravitational theory.

On body B the F and $\bar{F}$ coexistence.

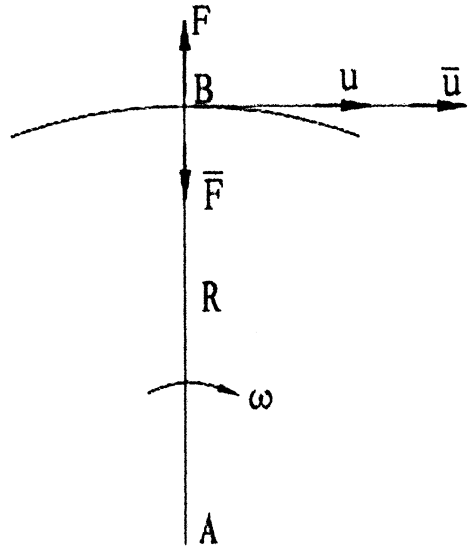

Fig.3. On body B the F and $\overline{F}$ coexistence and the new Universe model

From Fig. 3, it follows

$$F + \overline{F} = 0. \qquad (23)$$

From (21), (22) and (23) it follows

$$\frac{m}{M_B} = \frac{u^2}{c^2}. \qquad (24)$$

Body B increases mass m and centrifugal force is greater than gravitation force, then body B expands outward. Dark matter which causes cosmic attraction is wrong.

From above we prove that equivalence principle is not exist. Therefore, we prove that general relativity is the biggest wrong theory [11].

Using Fig.3 we establish the new universe model. The Universe has no beginning and no end. The universe is infinite.

(1) Body A is earth center, body B is the moon;
(2) Body A is the sun center, body B is the Earth;
(3) Body A is Galactic center, body B is stars in the milky way;
(4) .....
(5) Body A is the universe center; body B is the stars in the universe.

In Fig.3 on body B there is tardyonic centrifugal force and tachyonic centripetal force coexistence.

It is the universe foundations. All matter has unobservable tachyons to produce gravity. We should establish new cosmological theory and new particle physics theory.

From (22) it follows Newtonian gravitation formula. The m is proportional to body A

mass M_A, in (24) m is proportional to M_B, is inversely proportional to the distance R between body A and body B. It follows

$$m = k\frac{M_A M_B}{R}, \qquad (25)$$

where k is constant

Substituting (25) into (22) it follows the Newtonian gravitation formula [4-6,9-10]

$$\overline{F} = -G\frac{M_A M_B}{R^2}, \qquad (26)$$

where $G = kc^2 = 6.673\times10^{-8}\,\mathrm{cm^3/g\cdot sec^2}$ is gravitation constant.

Now we study the freely falling body. Tachyonic mass $\overline{m}$ can be converted into gravitational mass m, which acts on the freely falling body and produces the gravitational force

$$\overline{F} = -\frac{mc^2}{R}, \qquad (27)$$

where R is the Earth radius,

We have the equation of motion

$$\frac{mc^2}{R} = Mg, \qquad (28)$$

where g is gravitational acceleration, M is inertial mass of freely falling body.

From (28) it follows the gravitational coefficient

$$\eta = \frac{m}{M} = \frac{Rg}{c^2} = 6.9\times10^{-10}. \qquad (29)$$

Eötvös experiment $\eta \sim 5 \cdot 10^{-9}$ and Dicke experiment $\eta \sim 10^{-11}$. Since the gravitational mass m can be transformed into the rest mass in freely falling body, we prove that the freely falling bodies fall with the same acceleration and the equivalence principle is not exist. Therefore, we prove that general relativity is the biggest wrong theory [11].

3. The expansion theory of the universe without dark energy

Using new gravitational formula, we study the expansion theory of the Universe [9-10]. Figure 4 shows an expansion model of the Universe. The rotation ω_1 of body A emits tachyonic flow, which forms the tachyonic field. Tachyonic mass $\overline{m}$ acts on body B, which produces its rotation ω_2, revolution u and gravitational force

$$\overline{F}_1 = -\frac{mc^2}{R}, \qquad (30)$$

where R denotes the distance between body A and body B, m is gravitational mass converted into by tachyonic mass $\overline{m}$ which is unobservable but m is observable.

The rotation of the body B around body A produces the centrifugal force

$$F_1 = \frac{M_B u^2}{R}, \qquad (31)$$

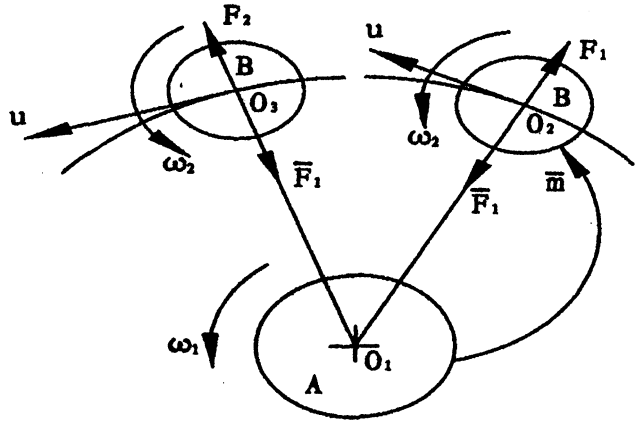

Fig. 4. An expansion model of the Universe

where M_B is the inertial mass of body B, u is the orbital velocity of body B. At the O_2 point we assume

$$F_1 + \overline{F}_1 = 0. \qquad (32)$$

From (32) it follows that the coexistence of the gravitational force and centrifugal force.

From (30)-(32) it follows the gravitational coefficient

$$\eta = \frac{m}{M_B} = \left(\frac{u}{c}\right)^2. \qquad (33)$$

At the O_3 point the tachyonic mass $\overline{m}$ can be converted into the rest mass m in body B, it follows

$$F_2 = \frac{M_B u^2}{R} + \frac{mu^2}{R}. \qquad (34)$$

Since $F_2 + \overline{F}_1 > 0$, centrifugal force F_2 is greater than gravitational force $\overline{F}_1$, then the body B expands outwards and its mass increases. This is an expansion mechanism of the Universe. From (31,32,34) we have

$$F_2 + \overline{F}_1 = \frac{mu^2}{R} = M_B g_e \qquad (35)$$

From (35) we obtain the expansion acceleration

$$g_e = mu^2 / M_B R$$

Substituting (33) in (36) we obtain

$$g_e = \frac{u^4}{c^2 R} \qquad (37)$$

If body A is the Earth, then body B is the Moon; if body A is the Sun, then body B is the Earth; .... It can explain our accelerating universe. In the universe there are no dark matter and no dark energy. This simple thought made a deep impression on me. It impelled me to establish a expansion theory of the universe. Dark energy responsible cosmic repulsion is wrong.

If the body A is the Sun and body B is the planet. We calculate the gravitational coefficients η as shown in table 1.

Table 1: Values of the gravitational coefficients η

Planet	u (km/sec)	$\eta(10^{-10})$
Mercury	47.89	255.2
Venus	35.03	136.5
Earth	29.79	98.7
Mars	24.13	64.8
Jupiter	13.06	19.0
Saturn	9.64	10.3
Uranus	6.81	5.2
Neptune	5.43	3.3
Pluto	4.74	2.5

The gravitational field of the solar system is the origin of the planet mass. From it the planet acquire mass. In the universe there are no Higgs particles. The equivalence principle does not exist. Therefore, we prove that general relativity is the biggest wrong theory [11].

4. Conclusion

In summary. We deduce tardyonic and tachyonic coexistence principle. Using it we deduce the centrifugal formula and new gravitational formula We establish the expansion theory of the universe without dark energy. The new gravitational formula is foundations of particle physics and cosmology. We prove that in the universe no dark matter, no dark energy, no gravitational waves and no quantum gravity.

Where did we come from? Where are we going? What makes up the universe? These questions have occupied mankind for thousands of years. Over the course of history, our view of the world has been changed. Theologians and

philosophers, physicists and astronomers have given us very different answers. Where did we come from? We answer this question this way $\bar{m} \rightarrow m$, tachyons $\rightarrow$ tardyons [1], that is tachyons can be converted into the electrons and positrons which are the basic building-blocks of the elementary particles [7-8]. In the universe there are no Higgs particles and no quarks. The standard model of particle physics is wrong. The tachyons are the origin of mass. Where are we going? We answer this question this way $m \rightarrow \bar{m}$, that is the tardyons produce tachyons [1]. The tardyons and tachyons make up the Universe.

Note. In 1976 Jiang found a gravitational formula [4]: $\bar{F} = -\bar{m}c^2/R$, where $\bar{m}$ is
the tachyonic mass. In 2004 Jiang studied the Universe expansion and found a new gravitational formula $\bar{F} = -mc^2/R$, where m is gravitational mass converted into by tachyonic mass $\bar{m}$ [9].
Compatibility of arbitrary speeds for interior dynamical problems implies a new scientific era [12]
Newtonian gravity formula is based on empirical evidence. He did not explain what is gravity? how it works? Equivalence principle does not exist, the gravitation must not be described by a "metric theory". The Einstein field equations are wrong. Therefore, we prove that general relativity is the biggest wrong theory [11].

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CONSEQUENCES OF THE EXISTENCE OF AN AETHER

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Abstract

This paper is written as an initial theoretical adjunct to the previous work, *Probabilistic Mechanics: the hidden variable* [1]. The marriage of the scientific discipline known as probabilistics to quantum theory has left the sciences in a position where causality has been neglected, even as the accuracy of predictive and empirical results is unparalleled. We advance the notion that the addition of a physically interpretive probabilistics as used to explain quantum theory is an ingenious necessity brought about by the suppression of the actual causal basis of observed effects. That missing causal basis, a longitudinal aetherial expression in bound relation to matter and in unbound relation in its absence, will serve to provide new causal explanations of results previously derived using probabilistic techniques. One such instance in need of physical, causal interpretation is that of electron tunnelling. This paper will put forward new speculative theory in that regard and interpret, initially, some aspects of existing working probabilistic theory.

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Introduction.

In 1984, Kenneth Thornhill produced two articles [2,3] which could be of great importance for the future of science and deserve to be better known and appreciated. Incidentally, both may be viewed on the etherphysics.com website. In the first of these, he considered the question of whether or not there is a physical ethereal medium in which electromagnetic waves propagate. He noted that many have argued that, since radiation is observed to possess many physical properties and cannot, therefore, exist in a true vacuum or void since, by definition, that would imply a total absence of anything physical. However, for more a hundred years now, it has been accepted widely that there simply is no physical ethereal medium and the physical properties of radiation have been transformed into waves and parcels of energy, or photons, in a space-time metric. He proceeds to examine briefly some of the arguments proposed to deny the existence of a physical ethereal medium but notes, crucially, that, if such a medium exists, then it could be deduced from Maxwell's electromagnetic equations that, since electric field, magnetic field and motion are mutually perpendicular for plane waves, its condensational oscillations are longitudinal, in analogy with sound waves in a fluid. He refutes another argument by showing that Planck's energy, distribution for a black-body radiation field may be derived quite simply for a gas-like aether with Maxwellian statistics. The assumptions he makes are made absolutely clear in his article, but all may be seen to be eminently reasonable physically. It might be noted also that Thornhill points out [2] that, according to his theory, the mass of an electron is roughly 2×10^9 times that of a unit aether particle. This indicates just how small these proposed aether particles are but, again according to Thornhill's theory, they would be moving at high speed and so, have high energy. Having derived this important expression, he proceeds in the second article to comment that electromagnetic waves may propagate in such an aether and the oscillating electric and magnetic fields in such waves may be observed to be transverse to the direction of wave propagation. He notes that, since electric field, magnetic field and motion are generally observed to be mutually perpendicular and coexistent, this suggests that such waves must also comprise longitudinal oscillations of motion of the aether itself, accompanied by longitudinal oscillations in pressure and density. Hence, such waves would possess the triality of being electromagnetic-condensational waves and their condensational aspect would, as mentioned already, be analogous to sound waves in a material gas.

In the second cited article [3], Thornhill points out that to justify what he has laid out as a concept of an aether, it is necessary to establish this triality of electromagnetic-condensational waves by showing that *all three* aspects of the waves propagate together along exactly the same wave fronts. For three space variables and time, the wave fronts are given by the characteristic hypersurfaces of the partial differential equations which describe the electric and magnetic field strengths as well as the motion of such an aether. As he also notes, all such hypersurfaces which pass through a given point in space-time have an envelope,

the characteristic through the point. What he went on to achieve in the article was to derive the characteristic hyperconoids both for the equations of electricity and magnetism in a gas-like aether and for the general equations for the unsteady motion of a gas in three space variables and show that they are, in fact, identical. It might be noted also that such an aether concept entails no transformation difficulties.

There can be no doubt that, taken together, these two papers contain a devastating indictment of a large part of modern physics but, in so doing, offer a glimpse of light at the end of a long tunnel of scientific discovery

Some Further Thoughts on Maxwell's Electromagnetic Equations

Following the lead proposed in several earlier articles [4 and references cited there], the Maxwell electromagnetic equations will be considered with the partial derivatives with respect to time replaced by the corresponding total derivatives; that is,

$$\frac{\partial}{\partial t} \rightarrow \frac{D}{Dt} + v.\nabla$$

In fact, as mentioned previously, this change allows for the correction of a piece of vital physics, *presented within CIA released documents seemingly closely associated with Tesla*, that has finally been revealed: a new solution to the equations of Maxwell allowing the representation and derivation of scalar wave phenomenon. Referring to the relevant equations in the *released* CIA document "CIA-RDP96-00792R000500240001-6",
https://www.cia.gov/library/readingroom/docs/CIA-RDP96-00792R000500240001-6.pdf,
it follows that with

$$\boldsymbol{E} = -\nabla\phi - \frac{1}{c}\frac{DA}{Dt} \text{ and } \boldsymbol{B} = \nabla \times \boldsymbol{A},$$

where ϕ is the scalar (electric) potential and $\bar{A}$ is the vector (magnetic) potential. The modified Maxwell equations, which have been derived from first principles [4] in an article which also clarifies the position of the dynamo mechanism for providing an explanation for the origin of planetary magnetic fields, then predict

$$\nabla^2\phi - \frac{1}{c^2}\frac{D^2\phi}{Dt^2} = 0$$

and

$$\nabla^2\boldsymbol{A} - \frac{1}{c^2}\frac{D^2\boldsymbol{A}}{Dt^2} = 0$$

As pointed out in the quoted article, a solution appears to exist for the case when

$$\boldsymbol{E} = 0,$$

$\boldsymbol{B} = 0$ and $\nabla \times \boldsymbol{A} = 0$ for a new wave satisfying

$$\boldsymbol{A} = \nabla S \text{ and } \phi = -\frac{1}{c}\frac{DS}{Dt},$$

with S then satisfying

$$\nabla^2 S - \frac{1}{c^2}\frac{D^2 S}{Dt^2} = 0.$$

These modified equations still assert that S is a potential with a wave equation – albeit a progressive wave equation – mathematically, which suggests the propagation of this wave even though $\boldsymbol{E} = \boldsymbol{B} = 0$ and the Poynting theorem implies no electromagnetic power flow. This wave is often termed a scalar wave in the literature but Thornhill's reference to a longitudinal wave is merely a different piece of terminology for the same thing; in both instances reference is being made to a longitudinal, or scalar, wave and it is one which progresses in a linear direction as a series of longitudinal oscillations of the aether itself but, crucially, accompanied by longitudinal oscillations in both pressure and density.

Hence it is seen that, even when no electric or magnetic fields are present, a solution of Maxwell's electromagnetic equations indicates the presence of a scalar – or longitudinal – wave just as when those fields are present. This would seem to indicate the continued presence of longitudinal oscillations in the aether and, again, these would be accompanied by longitudinal oscillations in both pressure and density. In turn, this would seem to imply a movement of energy in the aether in the direction of the disturbance and, as speculated in the released CIA document referred to above, this could only be energy in the aether itself.

Speculations.

This realisation that there is a longitudinal, or scalar, wave active in the aether, whether or not there are electric and/or magnetic fields present, leads to various other potentially interesting speculations. For example, it is currently felt that quantum mechanics offers the only possible explanation for such occurrences as tunnelling. Such an explanation, while it certainly has many merits, among which is the fact that it does offer an explanation for these effects, also suffers from seeming to be far removed from what many feel to be physical reality; the explanations depend on probabilities rather than on pure physics and, as in all other areas where probabilistic ideas are employed, this leads to doubt in the minds of some. After all, probabilistic ideas are usually, if not always, used in physics when some vital pieces of information needed for a truly exact analytical solution are missing. I good example to illustrate this latter point is provided by the use of statistical mechanics to aid in the investigation of systems containing large numbers of particles. In such systems, not all inter-particle interactions may be accounted for and there are, in general, far too many simultaneous equations to be solved for an exact solution. Hence, statistical techniques are employed and, to be fair, these have proved very useful. However, both in this latter example and in the case of quantum mechanical solutions where probabilistic notions are so vital, some queries still remain in the minds of many.

It is because of this uncertainty in the minds of many that these recent revelations concerning the possibility of a longitudinal wave in the aether carrying energy with it raises so much interest. Any particle moving along, be it in a gas or some other

medium, must be moving in the all-pervading aether. Hence, if such a particle encounters some obstacle such as a potential barrier, it becomes immediately conceivable that this longitudinal wave transmits a quantity of energy to the particle in question to enable it to overcome the mentioned barrier. Such a transfer would be accomplished via inter-particle collisions if Thornhill's concept of an aether [2] is valid. It is this first quoted paper of Thornhill which is so important as far as this particular point is concerned. His concept of an aether refers to a gas-like aether with Maxwellian statistics and the gas in question is said to be composed of an infinite variety of particles whose masses are integral multiples of the mass of the unit particle. This immediately shows that this notion of an aether is definitely one which possesses energy – energy which could be transferred through inter-particle collisions to other particles.

The above is a speculative argument but, provided Thornhill's aether concept is accepted, the argument is plausible and is one which, if accepted, could easily be extended to provide more physically realistic explanations for other phenomena regarded as being solely demonstrable by quantum methods up until now. However, the most immediate problem for most is to study Thornhill's work which, although it has been around for more than thirty years, is still not widely known and definitely not accepted as yet. The other interesting possibility here is the implied link-up with the pioneering work of Tesla since it seems it was, he who first broached the idea of the existence of these longitudinal, or scalar, waves. Seemingly, Tesla investigated the standing wave of an electrical nature and found it to be like standing waves he had observed during natural thunderstorms. In a piece appearing in the New York Herald Tribune in 1932, Tesla said that he 'showed that the universal medium is a gaseous body in which only longitudinal pulses can be propagated, involving alternating compression and expansion similar to those produced by sound waves in air.' [5]

A further point might be added concerning the use of the word 'aether' throughout this note. Since the early years of the last century, it has been well publicised that there simply is no such thing as a material aether. However, in the intervening time, the word 'vacuum' has taken on a far more widespread meaning than it had originally and has been given a quite detailed, complicated structure to make up for this lack of an aether. The whole idea of a vacuum has, in fact, been altered to make it, in effect, a material aether as is evidenced by the discussion in the book *The Structured Aether* [6].

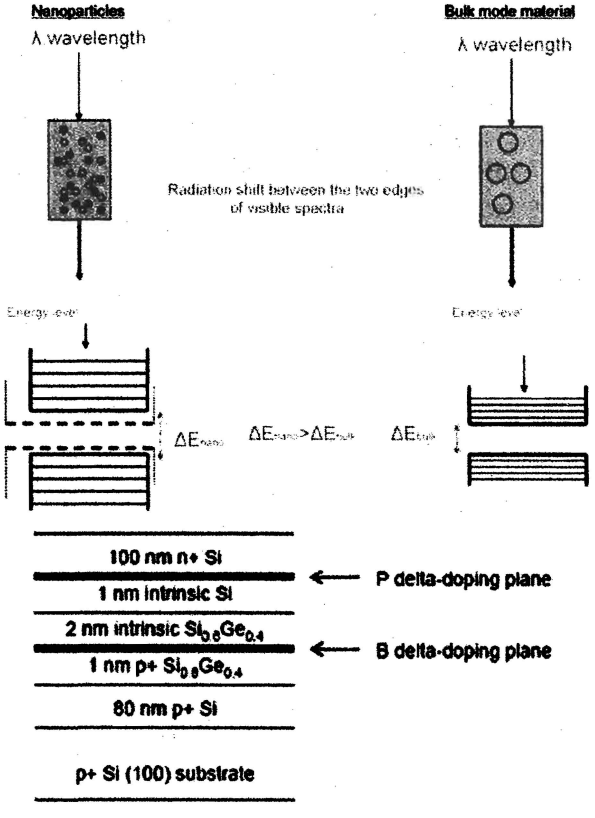
Some Further Thoughts.

Given the preceding reasoning, we may now theorize that conditions akin to those of particle collisions implied by Thornhill, meaning conditions permitting the mutual combination of, or other means of, increase of scalar wave energies are in play to causally explain statistically derived results associated with electron tunneling. Coherence between 'wave like aspects' of particles may be ascribed to functional constructive interferences of longitudinal waves associated with the

aetherial perturbations of those particles. We may observe this theory working in the tunneling diode and resonant tunneling diode.

As far as the tunneling diode is concerned, scalar waves may be understood easily as voltage over time expressions. The tunneling diode then functions by way of longitudinal summation due to alignment of *voltages*, by way of P and N type conductors which align at a particular voltage; a *voltage bias* encouraging by way of said alignment the longitudinal summation. Voltage, *pressure*, is made coherent across systemic expression so as to sum longitudinal waves and get the energies needed to classically surmount the barrier.

The resonant tunneling diode also coherently aligns voltage energies, but also uses confinement within a quantum potential well to raise energies [http://www.iue.tuwien.ac.at/phd/kosik/node64.html]. Confinement increases voltage by way of approaching nm scales. Less volume and so more pressure, meaning of course increased voltage energy by way of increased charge density. So the resonant tunneling diode functions by way of quantum confinement and voltage coherent scalar wave constructive interference.



Confinement and the architecture of the resonant tunneling diode.

Probability fields are in fact scalar fields (see: *Probabilistic Mechanics: the hidden*

variable). At this juncture, we may note that the *probability amplitude*, which always reduces after barrier passage in electron tunneling, appears to represent a real physical quantity: that of a reduced scalar voltage associated with any electron post tunneling. We infer that the probability amplitude in question could well represent an actual *scalar voltage amplitude*.

We may then re-define coherence itself, as a system-state based in those conditions needed to permit particle associated intra-systemic aetherial scalar wave interactivities and interferences.

Further speculation is then possible concerning the probabilistically derived relations between tunneling and nuclear processes, allowing speculation concerning the causal origins of the strong force. Tunneling probability is associated with nuclear decay and then also *the energy released.* Scalar waves which act to connect systemic components utilize inductive processes to create anti-correlation in the case of nonlocality, see *Probabilistic Mechanics, the hidden variable* [6]. Here, we may see the origins of the strong force.

The strong force may be viewed as induction via scalar wave in that induction produces opposite charges in the nuclear components, then hyper-energized with scalar voltages at close nuclear distances to account for the potency of the strong force. When the nucleus decays, the energies released are associated with the scalar wave voltages which bound the nucleus. Hence, we infer the cause of the probabilistic relationship between tunnelling, nuclear decay and energy release.

As we study longitudinal waves as affected by heat energy and the mediums through which they travel, it becomes possible to deduce the reasons. Classically, the nuclear Coulomb barrier can not be surmounted via classical mechanics to create fusion in stars but may indeed be surmounted within quantum mechanics in relation to the probabilities of tunneling, which are also related to energy values in decay and half lives. Clearly there is fusion in stars. We have deduced probabilistic causality is related in its actual mechanics to scalar wave longitudinal expressions including, but not limited to, those perturbed in an aetherial medium forming a triality within transverse wave expression. Heat affects the energy of longitudinal waves, and their rate of travel. [7] The Coulomb barrier's strength increase is related to atomic number as is expected, due to its direct relationship to the strong force. Close nuclear distance scales indicate nuclear self-confinement due to excessive inductive voltages. We may deduce a principle:

Spherically confined nuclear scale induction (the strong force) produces an externally radiating counter force field: the Coulomb barrier.

Higher atomic number should increase barrier strength and also, energy release in decay must increase as well due to greater, more prolific inductive scalar wave voltages needed in increased particle group binding. As the particle-associated condensational longitudinal expression increases its energies with temperature, noting that the longitudinal wave is the organizing principle in physical systems [1], we may now see a plain relationship emerge also between heat, entropy and

informational content within systemic evolution:

As the temperature in the medium increases, the speed and energy of the longitudinal wave increases. Entropy and heat then, increase alongside informational content. The temperature/tunneling related narrow energy range Gamow window becomes causally accessible to us: the missing energy is added by temperature increase yielding increased energy and velocities for the longitudinal component of the triality fostering fusion reactions. That energy is then also necessarily related to the atomic number (mass) of the bound nucleus which breaks apart to release its strong force component energy value, and also half life which is related to the stability and strength of the strong force.

The narrow range of energies appears to imply the additional component of constructive longitudinal interference could also be a possible factor leading to energy increase, permitting the summation of longitudinal expressions between similarly aligned temperature affected aether particles, and other similarly voltage/energy constrained longitudinal expressions, in coherent, constructive longitudinal interference.

Hadronic implications:

Our new theory offers a self consistent model which fits the experimentally derived facts concerning the hadronic structure of the neutron. Abstract objects such as quarks, neutrinos and virtual gluons have no place in a factually grounded scientific theory. We will first examine neutrino and quantum theory within the context of the alternative theory of Santilli's hadronic science and the aetherino [8,9,10], reflecting empirically derived alternatives to the current theoretic models of the neutron, then fit the new ideas into place.

Logical inconsistencies of existing neutrino and quantum theory include

Neutrino theory inconsistencies:

1. A positive binding energy of 0.782 MeV is indicated to account for the rest energy difference between the constituent components of the neutron, the electron and the proton and the neutron itself. However, the Schrodinger equation does not admit such positive binding energies and can not account for the bound state of the electron within the hyper-dense medium of the proton.
2. Experiments plainly demonstrate a positive binding energy. However, in classical anti-matter theory the antineutrino is ascribed negative energy, contrary to experimentally derived data.
3. Antineutrinos have a null cross section for electron and proton interactions, contrary to experimental results.
4. Paradoxical results seem to indicate neutrino scattering effects implying some "particle" mass, yet no particle is detected. Such "particle scattering" sans particle implies another solution: a longitudinal impulse moving through a substantial surrounding energy density interacting with targets: the Aetherino.

Quantum theory inconsistencies:
1. The Schrodinger equation fails to produce correct physical solutions in the case of the experimentally indicated by a .782 positive binding energy over the rest energies of the proton and electron which is required to synthesize neutrons.
2. Quantum mechanics forbids the synthesis of the spin l/2 neutron from the bound state of the spin l/2 proton and spin 1/2 electron.
3. The electron being bound into the proton for the 15 m life of an isolated neutron is not permitted in quantum mechanics.
4. The magnetic moments of the proton and electron are insufficient to account for the magnetic moment of the neutron according to quantum theory.
5 The uncertainty principle does not allow the electron to be bound permanently within the proton in stable nuclei such as the deuteron.
6. The interpretation of internal neutron structure which is most parsimonious, is that of an electron bound within a proton, not that of quarks. A simpler neutron structure has been articulated. The undetectable free quark is no longer required.
7. The model of Hadronic Mechanics and Chemistry implies new hadronic fuels, possible stimulated nuclear decay and rapid safe elimination of radioactive nuclear waste [8, 9].
8. The neutron can be re-conceptualized as the hadronic bound state of the hydrogen atom with the electron orbiting within a proton (see figure 6 below). Ergo: the ordinary energy levels of the hydrogen atom may be rightly conceptualized as the excited states of the neutron.

The Aetherino of Santilli carries mass and charge zero, spin 1/2 and 0.78 energy [9, 10]; a longitudinal impulse and a scalar wave expression. [1].

The correct neutron structure as articulated by Santilli and repeatedly demonstrated in many experiments [9], is shown here:

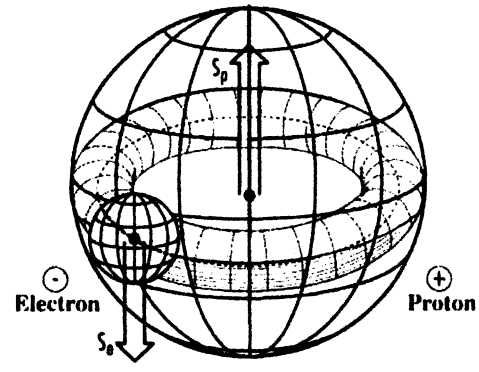


Image of the hydrogen atom's electron orbiting within the proton forming a neutron in
singlet coupling. The neutron is the hadronic bound state of the hydrogen atom.

The theories of Santilli clearly demonstrate the neutron is stabilized by way of anti-correlation and a singlet state. Now we may infer the cause of the stable neutron and hypothesize as to the internal function of the additional scalar wave aetherino.

Do note that our theory articulates the 0.782 MeV aetherino as the strong force itself, a positive binding energy acting by way of induction, acting, as it must, in inductive anti-correlation in order to create the stable neutron particle. The hadronic structure of a neutron is indeed that of an electron bound into the hyperdense medium of the proton by way of inductive scalar processes: anti-correlation established by intra-system inductive scalar connectomics via the aetherino scalar wave.

Conclusion:

Science has been suppressed and/or theoretically misinterpreted leading to errors which once corrected, could well lead to a new era where clean power is available to all through an understanding of the actual causes beneath the probabilistic world we see through quantum theory. This initial theoretical augmentation of previous work [1] outlining a preliminary basis to the new physics, suggests that quantum tunneling could also be redefined within this new causal context, and within that, electron tunneling. Those processes, we suggest, could well be causally explained along with the strong force itself through close examination of the phenomena of voltage alignment, confinement, and longitudinal scalar wave energy exchange within an aetherial medium.

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RESOLVING PROBLEMATIC THERMODYNAMICS

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Abstract

Thermodynamics is written in both classical and statistical formats. It will be shown that misunderstanding has allowed the science to become overly complicated. The concept of lost work in both expanding and compressed systems will be examined classically, showing why processes are irreversible here on Earth due to expanding system's interactions with the surrounding atmosphere. This new classical explanation allows for a simplification of the science, which should lead to the questioning and possible rewrite of statistical thermodynamics.

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Introduction

To most scientists, thermodynamics is an inarguably mature science. To some this is not the case [1, 2, 3], although different authors have proposed vastly different considerations as to why this is so, with some proposing rather complex theories[1]. This author realized something was wrong with the traditional construct of work when writing his paper concerning nucleation that was the first to correctly explain the energy required for bubble nucleation [4], wherein work/energy for nucleation was considered in terms of[4]:

$$W = dE + d(PV) \quad (1)$$

With dE includes the energy required to form a tensile layer while P and V respectively represent pressure and volume of a given system of nucleating molecules.

Although similar, eqn (1) challenged the conscript of bubble nucleation which throughout the 20th century was illogically believed to take the form [4,5,6,7,8]:

$$W = dE + VdP \quad (2)$$

Which puzzled this author because bubble nucleation involved both a volume and pressure increase, yet eqn (2) limits bubble nucleation to an isometric pressure increase. This all led to the questioning the construct of thermodynamics, wherein this author realized that work goes through a system's walls rather than into a system's walls, as was traditionally taught [9]. This also led to the understanding that a system can do work onto either a neighbouring system, and/or its surroundings, but not onto a vacuum[10]. Which led to the reasoning that Enrico Fermi's statement that the work associated with an expanding universe "goes into the hands of god"[10], was a statement based upon misconceptions[9], although it being mathematically plausible.

The accepted writing of energy change and work associated with an expanding system, in terms of isothermal entropy change is[11]:

$$TdS = dE + PdV \quad (3)$$

Where T is temperature, S is entropy, E is internal energy. Eqn (3) is readily rewritten in terms of the first law of thermodynamics by considering that the energy input (dQ) into an expanding system signifies isothermal entropy change, i.e.[11,12]:

$$dQ = dE + PdV \quad (4)$$

There are inherent problems with both eqn (3) and (4). As written, PdV lacks clarity, and, as such, many may think that the work is done within the expanding systems and/or in its walls. Realizing that work has to be done through the walls, this author realized that the work as defined by PdV, is done onto the surrounding

atmosphere[13] by the expanding system Moreover such work is irreversible, hence, is "lost work".

Interestingly, if one searches, one may find websites that now realize that work (PdV) is done onto the surrounding atmosphere but do not understand that it is lost work. Accepting that the atmosphere is a massive heat sink/bath then as such, measureable change to its parameters does not occur when normal real processes give or extract energy from it. I.e., the atmosphere tends to be isobaric, isothermal and/or isometric, from a perspective of measurement. Clearly, if an abundance of such real processes occurs, then the parameter change will become measureable. Another way of viewing this is that real processes affect the atmosphere in a similar manner that infinitesimal processes affect real systems.

So, although the real expanding system does work onto the atmosphere, the atmosphere remains both isobaric and isothermal. Accordingly, the atmosphere cannot return the work done onto it by real expanding systems. Yet another way of viewing this: A gaseous system can only do work onto its neighbouring system (or surroundings) if that system is at a higher pressure than its neighbouring system. Similarly: A system can only pass thermal energy onto its neighbouring system (or surroundings) if that system is at a higher temperature than its neighbouring system.

Since, after expansion, the system is at the same pressure and temperature as the atmosphere, then the atmosphere cannot return either work or energy back into the expanded system. Thus, PdV is lost work (i.e., irreversible work).

There is yet another issue with associating PdV in equations (3) and/or (4) with the expanding system. Since the internal energy change (dE) is a summation of the microscopic energies of the expanding system, it represents the change of the system's total energy! Therefore, the work as defined by PdV can only be external to that system. Seemingly defining dE in terms of summation of microscopic energies has allowed for plausible confusion.

In order to avoid confusion, eqn (4) should be written as[13]:

$$dQ = dE + (PdV)_{atm} \qquad (5)$$

Eqn (5) clarifies that the work done onto the atmosphere is an increase to its potential energy, that being an isobaric upward displacement of its mass. However, this is not exactly the case, because in reality an expanding system will cause a regional pressure increase within the atmosphere, and this may then result in an isobaric expansion of the atmosphere - i.e., PdV (Note: Here the expanding system is now considered as being part of the atmosphere as a system). Or the regional pressure increase may result in heat associated with viscous dissipation[14].

Consider that intermolecular collisions are inelastic, hence, only momentum is physically conserved. Heat (thermal photons) will also be radiated, thus

maintaining conservation of energy. Of course, this goes against accepted kinetic theory wherein all collisions are considered to be elastic. Interestingly, this author has shown that by considering the wall molecules to be massive energy pumps that pump their energetics onto colliding gas molecules then a new kinetic theory can be written[15,16]. A theory that no longer relies upon equipartition and most importantly, it better explains empirical findings, without the need of all those exceptions that are currently employed, so that traditional theory somewhat matches known empirical findings.

Moreover, we now can understand that intermolecular collisions are inelastic. Not only does this improve our understanding of kinetic theory, it also allows us to now understand why pressure-temperature relationships exist[14,15,16], i.e., pressure increases increase intermolecular collisions creating more heat. This also fits with our understanding that electron collisions are inelastic[17]. It should be stated that statistical ensembles, such as those for entropy, are wrongly based upon the collisions being elastic, hence, will require new considerations.

It is also of interest that one the many 20th century definitions for entropy is the "randomness of molecules in incessant motion" [18]. Ben-Naim[19] rightfully points out that randomness is in the eye of the beholder, hence, is not particularly scientific!

Furthermore, associating randomness with energy changes and/or work done to the gaseous molecules within the expanding system, may also lend itself to the incorrect assumption that all variables/parameters in eqn (4) has to do with those within the expanding system. This now raises the question: What exactly does the isothermal entropy change in eqn (3) concern? Sadly, this remains impossible to answer until the definition of entropy is clarified.

Isothermal entropy change is accepted to never decrease - i.e., the basis of the second law of thermodynamics for isolated systems. This brings up the question of "*Are any systems here on Earth truly isolated?*" Reconsider any expanding system doing work onto the surrounding atmosphere. Certainly, such systems are NOT isolated[13,14] because they do work onto their surrounding atmosphere! Accordingly, the second law does not apply to expanding systems here on the Earth's surface[13,14].

Since many useful systems depend upon expansion to power man and/or machine, then they are not isolated hence the second law does not apply to them. This is definitely the case for Carnot cycle and the steam engine, both of which are 19th century inventions for which the second law was devised.

In his 1917 "*Treatise on Thermodynamics*"[20] Planck acknowledges that there are two ways to formulate thermodynamics. A): "*We may take for granted the correctness of the mechanical view of nature and assume that all changes in nature can be reduced to motions of materials points between which their act forces which have a potential. Then the principle of energy is simply the well-*

known mechanical theorem of kinetic theory, generalized to include all-natural processes." Or B): As was done; "*leave open the question concerning the possibility of reducing all natural processes to those of motion, and start from the fact which has been tested by centuries of human experience and repeatedly verified*"... " *no way possible to have perpetual motion*".

Thermodynamics followed B) crafting the second law into the supreme postulate! In an interesting email exchange with Jeremy Dunning-Davis, Jeremy rightfully pointed out that the basic conscript for the second law did not necessitate the statistical form it now has. This implies that it was the simple understanding, as Planck states in B).

It must now be questioned whether or not our forefathers would had taken the stance they did if it was realized that work as defined in eqn (4) is irreversible, i.e., lost work that provides a description, which suits both of Planck's A) and B). Accordingly, this paper will investigate the application of the first law, i.e., equation (4), to both expansion and compression of ideal gases, incorporating our understanding of lost work.

For those who believe that irreversibility can only be explained by statistical arguments, I will assert the following. I am sure that statistical thermodynamics can be rewritten by the willing. And we are better served by formulating constructive logic and then finding a mathematical construct that fits that logic, rather than the other way around as the science is currently written/taught.

Before continuing, free energy must be discussed. In deriving his free energy, Gibbs started off with eqn (3), and then subtracts the following total differential:

$$d(TS) = dE + d(PV) \quad (6)$$

Logic dictates that we should start off with a total differential, from which we determine its partial derivatives. The only reason the absurdity of subtracting a total differential from a partial differential to obtain the other parts[3] was acceptable is it gave isothermal entropy change relation [eqn (3)] a sense of being supreme, which obviously it is not.

Furthermore, Gibbs famous paper[6] "On the equilibrium of heterogeneous substances" is published in two forms: A long 350 page paper followed by its short 50 page treatise. There is nothing wrong with this, however, they are both published in the same book under the same title and this is not particularly scientific[4]. When deriving his free energies both papers give a similar result, however, the same cannot be said of nucleation theory[4]! This has led this author to wonder how much other confusion exists due to this method of publication.

Getting to the heart of the problem, one must ponder: If dE is the change to the system's energy then what is $d(PV)$. In Gibbs derivation, he treats both dE and $d(PV)$ as if they are part of the same system, as seemingly described by eqn (6). Logic dictates that if PdV in eqn (4) is work done external to the expanding

system, then *d(PV)* is similarly external, i.e., part of the surroundings. This further begs the question: What does eqn (6) mean?

There are other plausible explanations for free energies as are given in my book[14]. Free energies amongst other concepts may be a case of getting things somewhat right for the wrong reasons. Anyhow in order to keep this paper from becoming a book, I will leave the free energies, solubility as well as numerous other considerations to future discussions.

A: Expanding Systems: Insulated: dQ>0

Consider a hermetically sealed expanding piston-cylinder filled with an ideal gas, as in Fig 1. As the vertically oriented piston-cylinder expands by a distance/height *dh*, its volume increases by *dV* and the work done is *PdV*. By understanding that the work is done onto the surrounding atmosphere, one avoids the confusion that students often have of: *PdV=-VdP*, inside of the piston-cylinder, i.e., why choose an isobaric volume increase over an isometric pressure decrease?

Since work done is through the expanding system's walls, then herein the expanding wall is the moving piston which does work into the surrounding atmosphere! And this is lost work, i.e., irreversible work!

In the above, we never discussed what drove the expansion. Let us say that the expansion was driven by heating as shown in Fig 2, hence, Eqn (4) applies. As we heat the insulated piston-cylinder then its temperature increases thus increasing its internal energy (*dE*) resulting in a pressure increase, which drives the piston outward from within the cylinder, thus doing work onto the surrounding atmosphere.

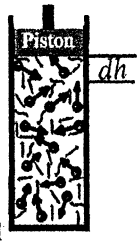
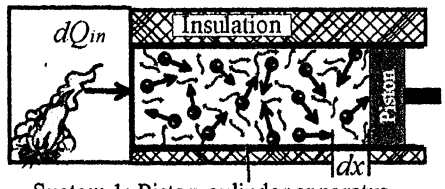


Fig.1 Shows an expanding piston-cylinder filled with an ideal gas and thermal radiation.



System 1: Piston-cylinder apparatus

Fig. 2 Shows a heated piston-cylinder whose temperature increase drives an isobaric volume increase. Hence, irreversible work is done onto the surrounding atmosphere.

Of importance: If the piston-cylinder is considered as a zero frictionless device, then the pressure in the piston-cylinder needs only be infinitesimally greater than that of the atmosphere, hence:

$$(PdV)_{pistoncylinder} \approx (PdV)_{atm} \qquad (7)$$

In terms of the ideal gas's isometric heat capacity (Cv), eqn (4) can be rewritten as:

$$dQ = CvdT + PdV \qquad (8)$$

And in terms of its isobaric heat capacity (Cp) eqn (8) can be rewritten as:

$$dQ = CpdT \qquad (9)$$

Obviously, a gas's isometric heat capacity equals its isobaric heat capacity plus the work done onto the atmosphere (PdV) by the expanding isobaric system. Thus, giving a simple explanation for the well-known empirical relation:

$$Cp = CvdT + PdV \qquad (10)$$

Eqn (10) previous explanation was based upon more complex entropy change arguments.

Note: In Fig 2, dx was used instead of dh. The reality is that it does not matter what direction the volume expands, because the Earth's atmosphere when displaced can only move in one direction that being upwards.

B: Expanding Systems: Insulated: dQ=0

Next consider that fifteen pebbles act as a weight on top of the piston-cylinder, as is shown in Fig 3. Five pebbles are then removed so the system isothermally expands. Again eqn (4) applies, but now dQ=0. Accordingly, the work comes from within the piston-cylinder. If the piston-cylinder is fully insulated, then, as it expands, it cools down in which case the work comes from the ideal gas's internal energy. Therefore, one might write for the expanding system:

$$dE = -PdV \qquad (11)$$

The accuracy of eqn (11) should be discussed. If PdV refers to the atmosphere, then it remains correct. Conversely, if PdV refers to the ideal gas inside of the syringe, then it does not.

The gas is doing the work. Since its pressure decreases as its volume increases, then, in terms of the gas's parameters, this work must be a logarithmic function of those parameters. We now start to understand why logarithmic functions are fundamental to thermodynamics, i.e., functions that previously were often attributed to entropy change.

Let subscripts "f" and "i" represent the expanding system's final and initial state, then, based upon the ideal gas law, setting $P=NkT/V$ and integrating work in terms of the expanding system's parameters gives:

$$W = -NkTIn(V_f / V_i) \qquad (12)$$

Can we then write?

$$(PdV)_{atm} \cong -NkTIn(V_f / V_i) \quad (13)$$

Eqn (13) is troubling because the two sides are never really equal unless we are dealing with infinitesimal rather than real work. Moreover, eqn (12) assumes that the expansion was isothermal, which it was not. Thus, eqn (13) is a rough approximation at best. Obviously, this simple process became mathematically complex.

Instead of a simple expanding insulated piston-cylinder, it does not take much for one to realize that this sort of logic will equally apply to systems containing/creating/using a defining quantity of energy. For example, in physical chemistry, isothermal entropy change is often contemplated in terms of logarithmic volume change and Boltzmann's constant (k), i.e.:

$$dS = kIn(V_f / V_i) \qquad (14)$$

We will get to entropy after we finish dealing with various types of expansion.

C: Expanding Systems: Not-Insulated: dQ=0

Consider a quasi-static expanding piston-cylinder that is not insulated. There is enough time for thermal energy to pass through the piston-cylinder walls into the expanding gas, thus keeping the process isothermal. Herein, some thermal energy from the surrounding atmosphere is "freely given". This freely given energy consists of both an increase to the gas molecule's kinetic energy (translational & rotational) plus its vibrational energy, as well as any increase in thermal radiation, which is generally minute when compared to the other energies. Note: The concept of kinetic energy being the summation of the gas molecule's translational plus rotational energy is a key element in making this author's new kinetic theory[15,16] better fit empirical findings.

Interestingly, for the above described quasi-static isothermal expansion, eqn (13) becomes slightly more valid, although the exact equality still only applies to infinitesimal processes!

Conversely, if the same piston-cylinder rapidly expands, it will cool down. And once fully expanded, it will slowly warm up as freely given thermal energy passes through its walls from the atmosphere back into the cooled expanded ideal gas.

This all becomes interesting because it gives us new insights into rapid processes, which are often deemed non-equilibrium processes. It also helps us understand why quasi-static processes are considered as processes that are in thermal equilibrium!

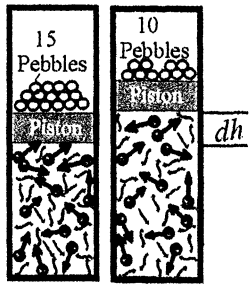


Fig 3 Shows a piston-cylinder expanding due to the removal of some weight (5 pebbles)

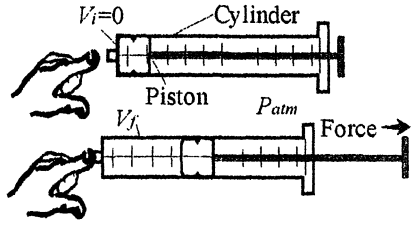


Fig. 4 Shows a hermetically sealed piston-cylinder being expanded by an external force.

D: Work in Creating a Vacuum

Consider the expansion of a vacuum by an external force. For example, take a syringe and place the plunger all the way to the bottom, then hermetically seal the syringe's opening with your finger as illustrated in Fig 4. Apply a volume expanding force. Since the internal pressure is not a function of the system's volume, then the required work is:

$$W = P_{atm}dV = (PdV)_{atm} \qquad (15)$$

E: Negative Work

"Negative work" conceptually feels counterintuitive; it can be mathematically expressed by placing a negative sign in front of the work term. The volume inside the expanded piston-cylinder in Fig 4 represents negative work done onto the volume of space that is being created within.

Reconsider the work done in creating a vacuum, but instead of thinking in terms of the work done onto the atmosphere, think in terms of the newly created volume of vacuum. Ignoring any blackbody/thermal radiation that enters through the cylinder's walls, then the final kinematic energy state within that created volume is zero. Accordingly, "negative work" was done (W_{neg}) onto the vacuum volume within the piston-cylinder:

$$W_{neg} = -W_{atm} \qquad (16)$$

Ask: Has the total energy of the atmosphere changed? No, it has not! Potential energy (PdV) was added to the atmosphere while negative work was done onto a volume within that atmosphere. In other words, the total energy associated with planet Earth and its surrounding atmosphere was not changed, even though the atmosphere's mass was upwardly displaced. Thus, the addition of a *volume of nothingness* (VON) does not alter the atmosphere's total energy.

Negative work tends to create unstable volumes. In the case of the expanded syringe, once the piston is released, then the piston will come crashing down into the cylinder eradicating the recently created volume within the syringe. The

mechanical understanding: This is due to the pressure inside of the syringe being less than the atmospheres.

This raises the question what happens to the energy used to form the vacuum? From a mechanical perspective, you could attach a string to the piston and do work when the plunger is released. From a thermodynamic perspective, things are slightly different. As the piston crashes into the cylinder, the gas molecules associated with the elevated atmosphere come crashing downwards. In other words, their potential energy is transformed into kinetic energy, which is similar to heating the atmosphere. Again, this heating would be infinitesimally small when compared to the atmosphere's thermal energy, i.e., the atmosphere is a heat sink.

If the piston-cylinder contained an ideal gas before expansion, then the work done onto the atmosphere would still be $(PdV)_{atm}$. One might roughly approximate this in terms of the ideal gas's parameters within the expanding piston-cylinder by:

$$W_{neg} = -(NkT)\ln(P_i / P_f) = -(NkT)\ln(V_f / V_i) \qquad (17)$$

F: Time Rates and Entropy

What happens if we consider the rate of expansion? For expansion by an input either external force or thermal energy, then this depends upon the input's magnitude. For processes with no input, then the rate of work depends upon the pressure difference between the expanding gas and atmosphere! In terms of some constant (A), the change in work rate (power) would be of the form:

$$dW / dt = -A\ln(P_{system} / P_{atm}) \qquad (18)$$

Without entropy how do we now explain the empirically known natural logarithmic functionality in thermodynamics? Consider: For any two systems in thermal contact, changes in heat transfer will depend upon variables such as surface area of contact, mass, heat capacity, and thermal conductivity. And it will be a logarithmic function of temperature.

The reason for the logarithmic function of temperature is that the rate of heat transfer will depend upon the temperature difference between the two systems or a system and its surroundings. As the temperature difference decreases, the rate of heat transfer decreases logarithmically. In other words, the rate of heat transfer should be a decreasing logarithmic function of time in terms of some constant (B), i.e.:

$$dE / dt = -B\ln(T_{hot} / T_{cold}) \qquad (19)$$

If one really thinks about it, correlations can be witnessed with other considerations of entropy change such as Atkins[21] claim that entropy signifies the quality of a system's energy. Even so, perhaps temperature better defines this quality because as an isolated energy source dissipates, its temperature decreases.

Similar arguments apply to Lambert's consideration of entropy being "the dispersal of a system's molecular energy"[23].

What about an exothermic reaction? The rate of heat transfer from the reaction into its surroundings will decline logarithmically as the reaction's energy disperses, i.e., cools. Again, this questions whether or not entropy is really needed!

G: Compression of a NOT insulated Piston-Cylinder

Consider that an ideal gas within a regular piston-cylinder is compressed. If the compression is quasi-static, then the compression can be an isothermal process if sufficient time is given for any heat created by viscous dissipation to radiate out through the walls of the piston-cylinder.

As the ideal gas's volume decreases, its pressure increases. When done isothermally, then, in terms of the gas within the piston cylinder, the work required for compression is:

$$W_{compression} = (NkT)\ln(P_f / P_i) = (NkT)\ln(V_i / V_f) \quad (20)$$

As the plunger moves down into the piston-cylinder, potential energy within the atmosphere again changes into kinetic energy, i.e., infinitesimal heating. Of course, if the plunger is released, it can do work and if this work is only done onto the atmosphere $[(PdV)_{atm}]$, then it's magnitude equals the kinetic energy increase experienced by the atmosphere during compression. Ultimately, the atmosphere's total energy remained constant during compression although potential energy transformed into kinetic energy.

H: Compression of an insulated Piston-Cylinder

Consider that an ideal gas within an insulated piston-cylinder is compressed. Now the ideal gas's temperature increases as the pressure increases. This can be viewed as either viscous dissipation or due to the fact that intermolecular collisions are inelastic. Since the temperature of the compressed ideal gas has increased, then eqn (20) no longer defines the work required.

If the insulated compressed gas is then allowed to expand, it will cool down. Assuming that the piston-cylinder is frictionless, then when the ideal gas returns back to atmospheric pressure it will also be isothermal with respect to the atmosphere. Again, in terms of the atmosphere, everything stated for the not insulated compression will apply to the insulated.

I: Global Warming:

The formation of our atmosphere involved work through processes like accretion. And as an approximation, we can think of our atmosphere as being in a state of approximate states of equilibrium. Or, at least, it is constantly trying to attain a state of both thermal equilibrium (temperature) and mechanical equilibrium (pressure). Any time that this is disturbed there should be consequences, some of which were described herein.

Whether this changes our understanding of man's influence concerning global warming, I cannot say. I can, however, attest to the likelihood that our models for global warming are based upon poorly conceived thermodynamics. Accordingly, the models may require a complete rethink if we are to improve the understanding.

J: Quantum Arguments:

There are numerous studies out there showing that quantum effects defy the second law[23]. Instead of questioning the statistically based second law, perhaps the question should be do these quantum processes disturb the natural state of our atmosphere? Certainly, some might, but the vast majority should not!

K: Conclusions:

The concept that thermodynamics is a well-understood mature science has been challenged and shredded. However, rather than continue with the over complication, the simplest approach conceivable was taken, namely, because simple arguments remain the best, and trying to direct entropy-based arguments remain futile until thermodynamic entropy receives clarity.

Our new perspective explains Fermi's misconception concerning the expanding universe. Most importantly, it adheres to both Planck's[20] "mechanical view of nature" and his understanding that there is "no way possible to have perpetual motion". It also fits this author's explanation of nucleation theory[4], wherein the energy required for bubble nucleation was finally explained thus matching empirical findings.

By understanding how expansion and compression affect our atmosphere, we now can visualize why processes here on Earth's surface are irreversible. Accordingly, statistical based second law arguments are no longer required to explain this. The consequences of this will be unfathomable to many readers, especially those who are intimately familiar with currently accepted thermodynamics theory.

Specifically, we examined lost work[13] that being the transfer of the potential and/or thermal energy into the atmosphere by expanding systems, whose total is defined by $(PdV)_{atm}$. This is best explained in terms of the atmosphere having mass within a gravitational field, hence, its displacement generally involves this irreversible work. For expanding systems, it can be thought of in terms of an atmospheric potential increase. However, in reality intermolecular collisions are

not elastic as was discussed in this author's papers concerning kinetic theory[15,16], where a superior fit to known empirical data was obtained. Hence, viscous dissipation often results in infinitesimal atmospheric temperature increases. Interestingly, inelastic intermolecular collisions also provide an explanation for pressure-temperature relations.

Whether we consider a volume increase (potential energy increase) and/or a temperature increase (viscous dissipation), for real processes that are generally experienced here on Earth, such increases can be thought as infinitesimal when compared to our atmosphere's total energy. However, if a large, significant number of such real processes do occur, then we may have to reconsider how this all influences our planet's warming.

It was shown that not clearly defining which parameters define the work done by expanding systems, has allowed the over complication of the science. It is this author's opinion that the thermodynamics needs an overhaul and that statistical thermodynamic can be rewritten to match our new enlightenment.

Interestingly lost work clearly explains the difference empirically known between isobaric and isometric heat capacity. Importantly, it does so without the complication of entropy change. Furthermore, we saw how logarithmic functions may be part of thermodynamics without the necessity of entropy.

What about the second law, wherein entropy of the universe is a "non-decreasing function of time"[24]? It is a false postulate. What about thermodynamic entropy itself? We discussed some plausible misunderstandings that may have led to entropy's rise and for its attendant unnecessary complexity.

I would like to thank Nick Percival for making this paper possible. Further thanks to Nick, and Dennis Allen for their input. And a final thanks goes to Jeremy Dunning-Davis for his insights although we tended to disagree on the significance of certain aspects.

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MATHEMATICAL, THEORETICAL AND EXPERIMENTAL ASPECTS OF SANTILLI'S SYNTHESIS OF THE NEUTRON FROM HYDROGEN[1]

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Abstract

In 1920, H. Rutherford conceived the neutron as a compressed hydrogen atom in the core of stars. He claimed that the first particle synthesized in stars is the neutron from a proton and an electron after which all known matter is progressively synthesized. However, W. Pauli noted that such synthesis of neutron violates the conservation of angular momentum. Therefore, E. Fermi proposed the emission of a massless particle, called "neutrino". In 1978, R.M. Santilli showed that, even though the angular momentum would be conserved, the neutrino hypothesis does not imply the validity of quantum mechanics for the neutron synthesis because the rest energy of neutron is bigger than the sum of rest energies of the proton and electron, under which conditions the Schrodinger equation becomes inconsistent. Further, Santilli observed that even though relativistic quantum mechanics (Dirac equation) is exactly valid for the electron at large distance from the proton in the hydrogen atom, but it is clearly inapplicable for the representation of electron when immersed inside the proton. In this paper, we present detailed Santilli's mathematical, theoretical and experimental research on neutron synthesis from hydrogen gas. It sequentially includes, (i) the construction of hadronic mechanics; (ii) the derivation of numerically exact and time invariant representation at the non-relativistic and relativistic levels of "all" characteristics of the neutron in its synthesis from a proton and an electron; (iii) the experimental verifications for the laboratory synthesis of the neutron from hydrogen gas and its industrialization. Within said covering context, we particularly show that the representation of proton as an extended, hyperdense and spinning particle implies the existence of an orbital angular momentum of the electron within the proton

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which is totally non-existence for quantum mechanics, under which the total angular momentum is conserved without any need for the conjectural neutrino. Santilli's experimentation reveals the existence of an intermediate state, named "neutroid" prior to neutron synthesis as predicted by the isomathematics. Neutroid then get absorbed by the natural elements, undergoes nuclear transmutation is confirmed by delayed detection of neutrons, beta and gamma radiations. Generally, neutroid produced when reactor is operated at low power and at relatively high pressure neutron production is detected by neutron detector.

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keywords: neutron, binding energy, isoelectron, Hulthen potential, Lie-Santilli isoalgebras.

1 Introduction

In 1920, Rutherford [1] submitted the hypothesis that hydrogen atoms in the core of stars are compressed into new neutral particles having the size of the proton that he called neutrons (**Figure 1**), according to the synthesis

$$p^+ + e^- \longrightarrow n. \tag{1}$$

The existence of the neutron was confirmed in 1932 by Chadwick [2]. How-

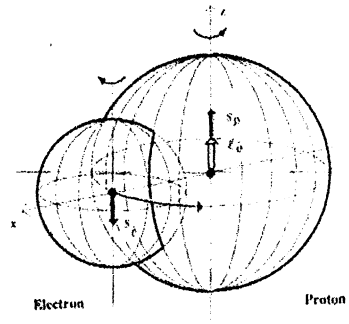


Figure 1: Compressed hydrogen atom: an electron penetrate into hyperdense medium of proton

ever, Pauli [3] noted that the spin 1/2 of the neutron cannot be represented via a quantum state of proton and electron, each having spin 1/2. Fermi [4, 5] adopted Pauli's objection and, he then developed the theory of weak interactions according to which the synthesis of the neutron is characterized by either the emission of a neutral and massless particle, named neutrino (ν) or absorption of antineutrino ($\bar{\nu}$). The particle reactions as per proposed theory of weak interaction are given by

$$p^+ + e^- \longrightarrow n + \nu, \quad \text{or} \tag{2}$$

$$p^+ + e^- + \bar{\nu} \longrightarrow n. \tag{3}$$

However, Santilli [6]-[10] has dismissed the Fermi's version of synthesis of neutron on following grounds:

1. the sum of the rest energies of the proton and of the electron,

$$m_p + m_e = 938.272\text{MeV} + 0.511\text{MeV} = 938.783\text{MeV} \tag{4}$$

is smaller than the rest energy of the neutron,

$$m_n = 939.565\text{MeV} \tag{5}$$

with positive energy (binding energy) difference of 0.78 MeV,

2. Santilli [6]-[10] pointed out that Schrodinger equation remains valid for an electron orbiting in a vacuum at large distances around the proton (exterior dynamical problem). Thus, the smallest bound state of a proton and an electron predicted by quantum mechanics is the hydrogen atom, where proton and electron at a distance which is equal to radius of Bohr orbit of the order of 10^{-8}cm. Moreover, Schrodinger equation neither yield consistent result for the same electron when it compressed within the hyper-dense medium inside the proton structure nor admit positive binding energy for quantum bound states when electron orbits within the proton structure at distances of the order of 10^{-13}cm,

3. quantum mechanics can only represent particles as dimensionless point masses; and has a purely local-differential structure. However, hadronic bound state arises due to deep penetration of electron into hyperdense medium of proton. This type of interaction lead to non-linear, non-local, non-Hamiltonian interactions,

4. classical theory of antimatter requires that the anti-neutrino has a negative energy, although, eq.(3) is needed positive energy to supply the missing energy, 0.78 MeV, neither antineutrino can deliver the 0.78 MeV needed for the neutron synthesis because the cross section of former with electron or proton is null, and

5. inability of traditional mechanics to represent the bell-shaped energy distribution in beta decay, since the said shape is due to the dependence of the energy on the angle of the beta emission caused by Coulomb interactions between the electron and the nucleus, with maximal value for a radial emission, and smaller energy values for smaller angles of emission,

6. the proton and the electron are the only experimentally discovered stable massive particles. Hence, emission of neutrino in neutron formation does not have any relevance. Moreover, it cannot be directly detected.

Due to all above constraints of conventional quantum mechanics, Santilli decided construct new mathematics, which would unambiguously resolve the above listed problems. His new mathematics [11]-[18] includes broadening of 20th century applied mathematics for the representation of extended particles in interior conditions. He first identified the mathematical structure needed for the representation of the neutron synthesis known as isomathematics [11]-[22]. He then constructed the corresponding physical methods known as isomechanics as a branch of hadronic mechanics and showed its validity for the representation of the class of systems under the conditions considered [6, 7]; then reached the representation of "all" characteristics of the neutron in its synthesis from the hydrogen at the nonrelativistic [23, 24] and relativistic [25, 26] levels; and then conducting systematic experiments on the synthesis of neutrons from a hydrogen gas by achieving the first known direct detection of synthesized neutrons via neutron detectors [27]-[33]. (see also reviews [34], international patent pending). As a result of these studies, the U. S. publicly traded company Thunder Energies Corporation (thunderenergies.com) is now in production and sale of a Thermal Neutron Source (TEC-TNS) providing the controlled production of low energy neutrons from a commercially available hydrogen gas.

2 Mathematical Aspect of Neutron Synthesis

Santilli found that the celebrated Schrodinger's equation for quantum physics is not suitable for obtaining positive binding energy for bound state which is necessary for the synthesis of neutron. He also found that the proposal of neutrino or antineutrino is also incomplete, because latter can not practically deliver the missing energy (0.78 MeV) needed for the neutron synthesis as the cross section of it in comparison to electron or proton is null. In order to remove these shortcomings, Santilli has developed isomathematics [11]-[18] and then hadronic mechanics [6, 7], which allowed the time invariant representation of Hamiltonian and non-Hamiltonian interactions involved in neutron synthesis. With meticulous presentation of isomathematics and taking care of all aspects of hadronic bound state, he successfully solved the anomalies pertaining to the binding energy, the spin and the magnetic moment. He calculated missing positive binding energy via isonormalization of the mass for electron when totally immersed within the hyper-dense medium inside the proton. Considering Rutherford's compression of the isoelectron within the proton in the singlet coupling, he also identified the spin half for neutron and calculated the magnetic moment of the neutron. We will discus all these mathematical aspects in subsequent section.

2.1 Hadronic Energy

The only bound state of a proton and an electron predicted by quantum mechanics is the hydrogen atom, with smallest orbit (Bohr's orbit) of the order of 10^{-8}cm. Santilli's hadronic mechanics has identified the existence of an additional bound state when the electron orbits within the proton structure at distances of the order of 10^{-13}cm or less. The difference between these two bound states is depicted in **Figure 2**.

Remarkably, Santilli has proved that the hadronic state is one and only one, the neutron, and its first excited state is the Hydrogen atom which is formed when the electron leaves the proton structure, thus recovering all conventional quantum states. In this sense, the energy levels of the hydrogen atom are the excited states of the neutron. The mutual overlapping of the charge distribution or wavepackets of electron and proton leads to new interactions of contact type. However, it is not possible via conventional quantum mechanics to represent these new interactions for various reasons, such as:

1. quantum mechanics can only represent particles as dimensionless point

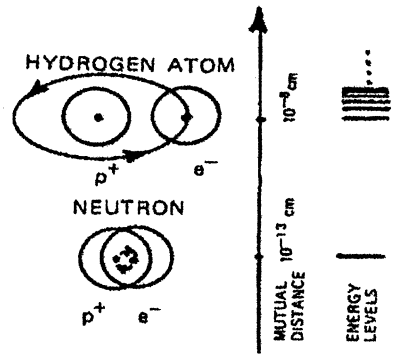


Figure 2: Difference between bound state predicted by quantum mechanics and hadronic bound state

masses; quantum mechanics has a local-differential structure ruling out any consistent treatment of the nonlocal integral interactions;

2. quantum mechanics can only represent interactions derivable from a local potential, while contact interactions of the type required to be considered herein can be represented with anything except a potential or a Hamiltonian.

In this event, Santilli's isomechanics [6]-[7] is ideally suited for a quantitative study of the neutron synthesis because, in addition to all interactions characterizing the hydrogen atom, it allows the new interactions caused by deep mutual penetration of the constituents (**Figure 3**). This method has been used by Santilli in numerous applications. Santilli [6]-[7] obtained an isoequation for the neutron by isotopically lifting of Schrodinger equation introducing additional potential term of Coulomb nature that reads as,

$$\left[\frac{1}{m}\widehat{p}\times\widehat{T}\times\widehat{p}\times\widehat{T}-\frac{ze^2}{r}+\frac{e^2}{r}\widehat{T}\right]\times\widehat{\psi}(r)=E\times\widehat{\psi}(r) \tag{6}$$

with isounit,

$$\widehat{I}=U\times I\times U^{\dagger}=1/\widehat{T}>0. \tag{7}$$

The suitable isounit to represent the two particle penetration (now termed

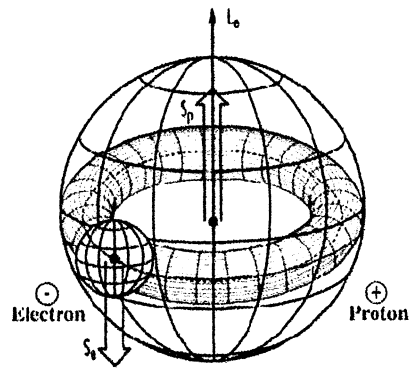


Figure 3: A schematic representation of bound state when electron completely immersed in hyper dense medium of proton

as an isoelectron), is defined as,

$$\widehat{I} = Diag\left(n_1^2(1), n_2^2(1), n_3^2(1), n_4^2(1)\right) \times Diag\left(n_1^2(2), n_2^2(2), n_3^2(2), n_4^2(2)\right) \times \exp\left((\psi/\widehat{\psi}) \times \int \widehat{\psi}(r)^{\dagger}_{1\downarrow} \times \widehat{\psi}(r)_{2\uparrow} dr^3\right) \quad (8)$$

where the two diagonal matrices represent the shapes (assumed to be spheroids) and the densities of the particles considered, while the last term represents the non-Hamiltonian interactions. For spherical point-like charge particle, such as electrons, the diagonal matrices get reduced to 1. Next, the evaluation of the volume integral into a constant,

$$N = \int \widehat{\psi}(r)^{\dagger}_{1\downarrow} \times \widehat{\psi}(r)_{2\uparrow} dr^3, \quad (9)$$

and the expansion of the isoexponent up to the second term, yields,

$$\widehat{I} \approx e^{N \times \psi/\widehat{\psi}} \approx 1 + N \times \psi/\widehat{\psi} \quad (10)$$

$$\widehat{T} \approx e^{-N \times \psi/\widehat{\psi}} \approx 1 - N \times \psi/\widehat{\psi} \quad (11)$$

$$|\widehat{I}| \gg 1, \quad |\widehat{T}| \ll 1, \lim_{r \to 1\text{fm}} \widehat{I} = 1. \quad (12)$$

In above equations; ψ and $\widehat{\psi}$ behave respectively as

$$\psi \approx P \times e^{-br} \quad (13)$$

$$\widehat{\psi} \approx Q \times (1 - e^{-br})/r \tag{14}$$

where P and Q are constants and b is inverse of hadronic horizon, r_h. Using eqs.(13) and (14), the isotopic element depicted in eq.(11) reads as

$$\widehat{T} \approx 1 - N \times \psi/\widehat{\psi} = 1 - r \times V_0 \frac{e^{-br}}{(1 - e^{-br})}, \tag{15}$$

where $V_0 = NP/Q$. Now, by introducing Hulthen potential,

$$V_{Hulthen} = V_0 \frac{e^{-br}}{1 - e^{-br}} \tag{16}$$

where V_0 is the Hulthen's constant, the isotopic element can be written as

$$\widehat{T} \approx 1 - N \times \psi/\widehat{\psi} = 1 - r \times V_{Hulthen}. \tag{17}$$

Further, at small distances, the Hulthen potential behaves like Coulomb potential,

$$V_{Hulthen} \approx \frac{V_0}{b \times r}. \tag{18}$$

which is very strong as the quantity b in the denominator is of the order of 10^{-13}cm, thus resulting the multiplicative factor of the order of 10^{13}. As a result, inside the hadronic horizon, the Coulomb potential is absorbed by the Hulthen potential, thus we can write

$$\frac{e^2}{r} \times \widehat{T} - \frac{ze^2}{r} \approx \frac{e^2}{r} \times (1 - r \times V_{Hulthen}) - \frac{ze^2}{r} = -V \times \frac{e^{-br}}{(1 - e^{-br})} \tag{19}$$

where $z = 1$ and $V = e^2 V_0$.

Using eqs.(6) and (19), Santilli obtained the nonrelativistic radial isoequation of the hadronic two-body structure model that reads as

$$\left[\frac{1}{r^2}\left(\frac{d}{dr} r^2 \frac{d}{dr}\right) + \frac{m}{\rho^2 \hbar^2}\left(E_{hb} + V \frac{e^{-br}}{1 - e^{-br}}\right)\right] \times \widehat{\psi}(r) = 0 \tag{20}$$

where E_{hb} is hadronic binding energy. Assuming the change of variable, $x = 1 - e^{-hr}$, eq.(20) can be written as

$$\left[x(1 - x)\frac{d^2}{dx^2} - \left(2|A|^{1/2} + 1\right)\frac{d}{dx} + \beta^2\right] S(x) = 0 \tag{21}$$

where

$$k_2 = \frac{mV_0}{\hbar^2\rho^2b^2}, \quad A = \frac{m}{\hbar^2\rho^2b^2}E_b < 0, \tag{22}$$

The solution of eq.(21) is then given by

$$G_n(x) = \sum_{k=1}^{k=n} \binom{n-1}{k-1} \binom{n+k+2\left|A\right|^{1/2}-1}{k} x^k \tag{23}$$

with isonormalized isoeigenfunction

$$\widehat{\psi}(r) = \left[\frac{\Gamma\left(2\left|A\right|^{1/2}+3\right)}{\Gamma(3)\,\Gamma\left(2\left|A\right|^{1/2}\right)}\right]^{1/2} \quad \frac{1-e^{-br}}{r} \quad e^{-\left|A\right|^{1/2}br} \tag{24}$$

the expression for hadronic binding energy is then obtained as

$$\left|E_{hb}\right| = E^{Bind} = \frac{V_0}{4k_2}\left[\frac{k_2}{n} - n\right]^2. \tag{25}$$

The boundary conditions demand that $k_2 > n$. This indicates the finite value of eigenvalues for Hulthen potential. This is in concurrence with the hadronic bound state. Further, for an isoparticle to be bounded inside the hadronic horizon b^{-1}, its wavelength, λ must be proportional to the horizon itself, and we shall write

$$\lambda = \frac{1}{2\pi k_1 b} \tag{26}$$

where k_1 is a positive quantity that must be constant for a stationary state. Next the hadronic kinetic energy E_{hk} is given by

$$E_{hk} = \frac{\widehat{p}^2}{2m} \approx \frac{\hbar^2\rho^2b^2}{2m}. \tag{27}$$

Now, from eqs.(22) and (27), we have

$$V_0 = 2k_2E_{hk}. \tag{28}$$

Hence, the hadronic total energy of the hadronic bound state is given by

$$E_{ht} = 2E_{hr} + 2E_{hk} - E_{hb} \approx 2k_1\left[1-(k_2-1)^2\right]\hbar bc_0. \tag{29}$$

where c_0 is the speed of light in vacuum, and note that the last approximation holds for hadronic bound states where the rest energy is insignificant with respect to the kinetic energy. Thus, at this point we obtained the expression for the total energy of the two-body hadronic bound state which is depend on two unknown quantities, k_1 and k_2. To achieve a numerical solution, we now introduce second expression, the meanlife, τ of the unstable hadron

$$\tau^{-1} = \lambda^2 \left|\widehat{\psi}(0)\right|^2 \frac{\alpha^2 E_{hk}}{\pi\hbar}, \tag{30}$$

where α is the fine structure constant. By using the above expressions, we can write

$$\widehat{\psi}(0)\left[\frac{1}{2}\frac{(k_2-1)\,\Gamma\left[\frac{1}{2}(k_2-1)+2\right]}{3!\Gamma\left[\frac{1}{2}(k_2-1)+2\right]}\right]^{1/2} b = \frac{(k_2-1)^{3/2}}{(48)^{1/2}}b \tag{31}$$

The meanlife of the hadronic bound state then becomes

$$\tau^{-1} = \frac{4\pi}{48\,(137)^2}\frac{(k_2-1)^3}{k_1}bc_0 \tag{32}$$

Thus, we obtained a system of two equations in terms of two unknown quantities k_1 and k_2, total rest energy, E_{tot}, the meanlife, τ and the charge radius, R_c of the two-body hadronic bound state, that it is reproduced identically below:

$$k_1\left[1-(k_2-1)^2\right] = \frac{E_{ht}}{2\hbar bc_0} \tag{33}$$

$$\frac{(k_2-1)^3}{k_1} = \frac{48\,(137)^2}{4\pi bc_0}\tau^{-1}. \tag{34}$$

On substituting $b = 10^{-13}$, $\tau^{-1} = 10^{-3}$ and $E_{th} = 939$ in eqs.(33) and (34), we extract

$$k_1 = 2.6, \quad k_2 = 1 + 0.81 \times 10^{-8} \approx 1. \tag{35}$$

For admissible state, $n = 1$, we further have

$$\frac{k_2}{n} - n \approx 0, \tag{36}$$

$$E_{hb} = -\frac{V_0}{4k_2} \times \left(\frac{k_2}{n} - n\right) \approx 0 \tag{37}$$

Thus, this proves that the in nonrelativistic approximation the hadronic binding energy is insignificant. Further, the numerical value of the hadronic kinetic energy is obtained as

$$E_{hk} \approx k_1 \hbar b c_0 = 6.63 \times 10^{-23} \text{MeV} \approx 0 \tag{38}$$

which is also insignificant. The reason for being very small hadronic binding energy and ignorable in first approximation is due to the fact that contact resistive forces have no potential energy. The main physical origin of hadronic structure is the contact, zero-range, interaction due to the complete immersion of one wavepacket within the other.

Finally, Santilli arrives at the following result namely the total hadronic energy of the neutron is primarily characterized by the rest energy of the proton and the isonormalized rest energy of the isoelectron,

$$E_n \approx E_p + E_{hr,\widehat{e}} = E_p + \frac{m_e c_0^2}{\rho^2} = 938.272 + 1.293 = 939.565 \text{MeV} \tag{39}$$

where $\rho^2 = 0.3952$ is a geometrization of the departure of the interior of hadrons from our space-time.

Santilli obtained exact solution of hadronic energy without considering either emission or absorption neutrino. Over the years, the credibility of neutrino hypothesis is declined due to the several theoretical and experimental inconsistencies. There are several discrepancies with neutrino hypothesis, for examples : extending the original hypothesis to electron, muon, and tau neutrinos without directly verifiable physical differences; then their interchange without a clear physical process; then the assumption that neutrinos have masses; neutrino as massive particles can cross entire planets and stars without appreciable scatterings.

The excessive rareness of the experimental evidence, although it is claimed that the existence of the neutrino, compared to the extremely large number of events. For example: the flux of solar neutrinos reaching earth is of the order of trillions of neutrinos per square centimeter per second while, by comparison, their experimental detection has been so limited that the Italian Government terminated the operation of the neutrino tests at the Italian Gran Sasso Laboratory. In all these circumstances, the etherino hypothesis (detail description of etherino is given section 7) is more plausible since the etherino propagates through the universal substratum underlying nuclei and all matter [36]. The absence of large amount of energy in the synthesis of neutron will be compensated via the etherino involvement in the process.

2.2 The Neutron Spin

As per the hadronic mechanics bound state is singlet. For the state with deep overlapping of electron and proton wavepackets (non-linear, non-local effect), only singlet state is possible. However, in conventional quantum mechanics, the particles are regarded as point-like abstraction, so which may have both singlet and triple bound states **Figure 4**. For better understand-

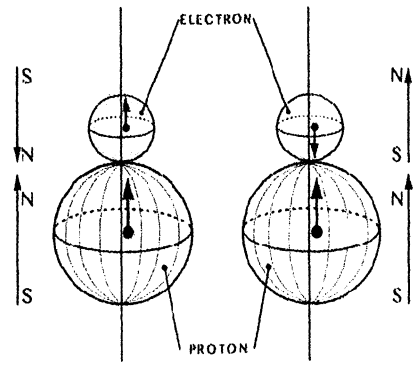


Figure 4: Schematic representation of triplet and singlet states for the proton-electron bound state

ing of singlet hadronic bound state (**Figure 5**) we consider the gear model (**Figure 6**) where two gears are placed together with opposite spins for persistence of their movement. However, two gears with same spin orientations are never bound together. The conceptual interpretation of the observed spin 1/2 of the neutron, for the first, was successfully explained by Santilli as follows. Considering the initiation of Rutherford's process of compression of the isoelectron within the proton in singlet coupling, it is evident that, as soon as the penetration begins, the isoelectron is trapped inside the hyperdense medium inside the proton, thus resulting in a constrained orbiting motion of the isoelectron that must superpose on the proton spin (**Figure 3,7**). Santilli stresses that the proton is not mutated because it is 2000 times heavier than the electron, and that the coupling must be in singlet for stability. This implies that, for the case of the neutron structure, the spin of the electron is also not mutated. However, the angular momentum of electron is mutated inside the hadronic sphere. The needed mutation of the quantum angular momentum into the hadronic one is trivially given by the nonunitary

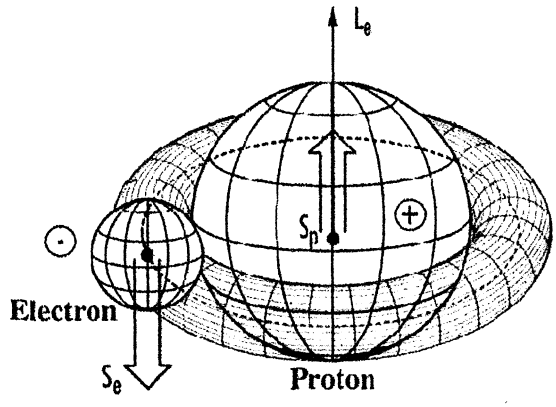


Figure 5: A structure of neutroid, an intermediate state of neutron formation, electron about to penetrate in the hyperdense medium of heavy proton

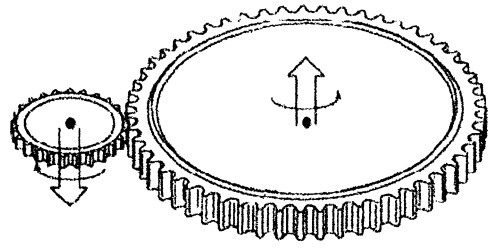


Figure 6: Santilli's gear model (smaller gear represents electron and bigger one represents proton) showing why proton and electron should have opposite spin orientations for formation of the neutroid

transforms

$$U \times U^\dagger = \widehat{I} = \frac{1}{2}, \qquad \widehat{T} = 2, \tag{40}$$

The mutation is supported by the isotopic invariance of the Hilbert space. Nonunitary lifting of angular momentum, in this case, reads

$$\begin{aligned} \langle l, m| \times L_3 \times |l, m\rangle \times I \rightarrow U \times [\langle l, m| \times L_3 \times |l, m\rangle] \times U^\dagger \\ = \langle \widehat{l}, \widehat{m}|2 \times \widehat{L}_3 \times 2|\widehat{l}, \widehat{m}\rangle \times \frac{1}{2}, \end{aligned} \tag{41}$$

In order to represent the spin of neutron Santilli (1990) used irregular isorepresentations of Lie-Santilli isoalgebras[11]-[13], namely, isorepresentations char-

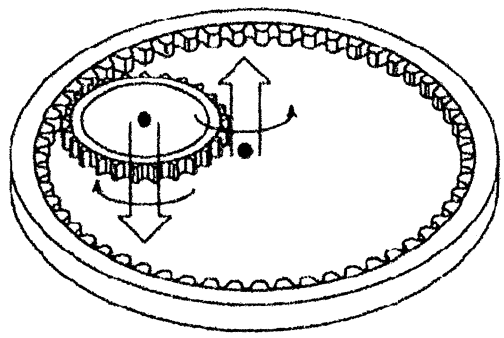


Figure 7: A gear model (Smaller gear has to rotate inside the bigger one) when electron fully immersed in proton medium

acterized by nonunitaryisounitary transforms for the generators different than those for the product. This difference is rather natural for the structure of the neutron, since the basic nonunitary transform for the rest energy has already been selected for calculation of binding energy. This irregular isopresentation of $\widehat{\mathrm{SO}}(3)$ based on the the isodifferential calculus and isolinear momentum is given below:

$$[\widehat{r_i},\widehat{r_j}] = [\widehat{p_i},\widehat{p_j}] = 0, \tag{42}$$

$$[\widehat{r_i},\widehat{p_j}] = \widehat{\delta_{ij}} = \widehat{I} \times \delta_{ij} = \rho\delta_{ij}, \tag{43}$$

$$\widehat{L^2}\widehat{\times}\widehat{Y}_{\widehat{l}\widehat{m}}(\widehat{\theta},\widehat{\phi}) = \rho^2 \times \widehat{l}(\widehat{l}+1)\widehat{Y}_{\widehat{l}\widehat{m}}(\widehat{\theta},\widehat{\phi}), \tag{44}$$

$$\widehat{L_3}\widehat{\times}\widehat{Y}_{\widehat{l}\widehat{m}}(\widehat{\theta},\widehat{\phi}) = \rho \times \widehat{m} \times \widehat{Y}_{\widehat{l}\widehat{m}}(\widehat{\theta},\widehat{\phi}), \tag{45}$$

$$\widehat{l} = 1, 2, 3, ... \qquad \widehat{m} = \widehat{l}, \widehat{l}-1, ..., -l. \tag{46}$$

Notice that the isotopic lifting of the integer value of the angular momentum, $l = 1, 2, 3, ...$ into the value $\rho \times \widehat{l}$, where, again, $\widehat{l} = 1, 2, 3....$, the value $\widehat{l} = 0$ being excluded by boundary conditions, ρ being a variable depending on the local conditions. For the study of the neutron spin on the line of hadronic mechanics, Santilli selected the following two-dimensional irregular isorepresentation of $\widehat{\mathrm{SU}}(2)$:

$$\widehat{I} = \begin{pmatrix} g_{11} & 0 \\ 0 & g_{22} \end{pmatrix}, \qquad \widehat{T} = \begin{pmatrix} g_{11}^{-1} & 0 \\ 0 & g_{22}^{-1} \end{pmatrix} \tag{47}$$

$$\widehat{J}_1 = \frac{1}{2}\begin{pmatrix} 0 & g_{11}^{-1/2} \\ g_{22}^{-1/2} & 0 \end{pmatrix}, \qquad \widehat{J}_2 = \frac{1}{2}\begin{pmatrix} 0 & -ig_{11}^{-1/2} \\ ig_{22}^{-1/2} & 0 \end{pmatrix} \tag{48}$$

$$\left[\widehat{J}_1,\widehat{J}_2\right] = i\widehat{J}_3 = \frac{1}{2} \times \frac{\Delta^{1/2}}{2}\begin{pmatrix} g_{11}^{-1} & 0 \\ 0 & g_{22}^{-1} \end{pmatrix} \tag{49}$$

$$\widehat{J}_3 \times |\widehat{j},\widehat{s}\rangle = \widehat{J}_3 \times \widehat{T}|\widehat{j},\widehat{s} = \pm\frac{\Delta}{2}|\widehat{j},\widehat{s}\rangle \tag{50}$$

In this case, Santilli [11, 12, 16] has selected the two-dimensional irregular isorepresentation of $\widehat{\mathrm{SU}}(2)$ and then computed the total angular momentum of the neutron model, $n = (p^+, \widehat{e}^-)_{hm}$ as,

$$J_n = J_p + \widehat{L}_{\widehat{e}}^{\text{orbital}} + \widehat{J}_{\widehat{e}}^{\text{intrinsic}} = \frac{1}{2} + \rho - \frac{\Delta}{2} \tag{51}$$

resulting in the values anticipated above, namely:

$$\rho = \frac{1}{2}, \qquad \Delta = 1. \tag{52}$$

It shows that the spin of the isoelectron is not mutated and the angular momentum is mutated in such a way that the isoelectron is merely carried out by the proton spin.

Note that Rutherford's total "compression" of an electron within the hyper-dense medium inside the proton, in which case the electron is constrained by said medium to rotate with an angular momentum equal to the proton spin. The total angular momentum of the electron is null and the spin of the neutron is equal to that of the proton. The half-values of the angular momentum are prohibited in a vacuum, but are fully admitted within physical media due the isotopies of Lie's theory [19], [11]-[13]. In any case, values of the angular momentum different than 1/2 would imply that the electron moves inside the proton in a direction against its hyper-dense medium, which is a physically impossible. Moreover, Rutherford's total "compression" of an electron within the hyper-dense medium inside the proton is impossible for quantum mechanics, because the proton is point-liked particle. However, the above view has permitted to obtain numerically exact and time invariant representation of "all" characteristics of the neutron, including a representation of its anomalous magnetic moment.

In general, the approaches of isomathematics and isomechanics can be extended to any cases of the order of molecular range, for example; according to quantum mechanics and chemistry, identical electrons in valence couplings should repel each other, and certainly cannot attract each other contrary to the evidence that molecular structures are due to strongly attractive valence bonds between identical electrons. It should be indicated that non-linear, non-local and non-Hamiltonian interactions due to deep overlapping of the wavepackets of particles have been crucial for understanding the nature of attractive force between the identical valence electrons in singlet couplings as occurring in the reality of molecular structures [35]. Consequently, the new bond (Figures 4) are fully in concurrence with the bond of identical valence electrons in singlet coupling as occurring in molecular structures.

2.3 The Neutron Magnetic Moment

In view of the hadronic orbiting motion of isoelectron, the magnetic moment of the neutron was generated by Santilli by considering the following three contributions,

$$\mu_n = \mu_p^{\text{intrinsic}} - \mu_{\widehat{e}}^{\text{orbital}} + \mu_{\widehat{e}}^{\text{intrinsic}} \tag{53}$$

The observed values of magnetic moment of neutron and proton are respectively,

$$\mu_n = -1.9 \times \frac{e}{2m_p c_0}, \quad \mu_p = 2.7 \times \frac{e}{2m_p c_0}. \tag{54}$$

Now, on rearranging magnetic moment of neutron as

$$\mu_n = -1.9 \times \frac{e}{2m_p c_0} = 2.7 \times \frac{e}{2m_p c_0} - 4.6 \times \frac{e}{2m_p c_0}, \tag{55}$$

and comparing with eq.(54), we obtain following identity:

$$-\mu_{\widehat{e}}^{\text{orbital}} + \mu_{\widehat{e}}^{\text{intrinsic}} = -4.6 \times \frac{e}{2m_p c_0}. \tag{56}$$

This is equivalent to

$$-\mu_{\widehat{e}}^{\text{orbital}} + \mu_{\widehat{e}}^{\text{intrinsic}} = -2.5 \times 10^{-3} \times \frac{e}{2m_e c_0} = -2.5 \times 10^{-3} \times \mu_e. \tag{57}$$

From eq.(57), Santilli derived the desired value of, $\mu_{\widehat{e}}^{\text{orbital}}$, that is

$$\mu_{\widehat{e}}^{\text{orbital}} = (1 + 2.5 \times 10^{-3}) \times \mu_e. \tag{58}$$

The small value of the total magnetic moment of the isoelectron is fully compatible with the null value of its total angular momentum.

We know that quantum mechanics has been unable to achieve a representation of the magnetic moment of the simplest nucleus, the deuteron (instead of augmentation of all corrections, 1 percent is still missing) with drastic deviations from theoretical predictions for large nuclei such as that of plutonium. A similar situation has occurred for nuclear spins that have remained unresolved for nuclei at large. However, the fundamentals of isomathematics and isomechanics allows a deformable charge distributions under contact non-Hamiltonian interactions (protons and neutrons as extended), which eventually, permitted us to achieve the first known numerically exact and time invariant representation of nuclear magnetic moments and spins [37]- [39] for members of a nuclear structure.

3 The Neutroid

Prior to Santilli's thorough experimentation on synthesis of neutrons from a hydrogen gas, three scientists had ventured this experiment in laboratory: first by Ernest J. Sternglass in 1951 (including his interesting communication to A. Einstein), the second tests were done by E. Trounson in 1952, and the third tests were done by Don Carlo Borghi and his associates in the 1960's. The central idea in all these experiments is to synthesized the neutron from an electron and a proton. We know that hydrogen contains only one electron and a proton, therefore, it is the suitable candidate for this experiment. The main motive of the experiment was to compressed electron, orbiting in Bohr's orbit into the proton structure with suitable pressure and supply of electric arc energy. In 1960, Carlo Borghi, C. Giori and A. Dall'Olio [40, 41] performed the experiment at CEN Laboratories, Recife, Brazil. Hydrogen gas at fraction of 1 bar pressure (was obtained from the electrolytical separation of water) was placed in the interior of a cylindrical metal chamber (called klystron) and kept mostly ionized by an electric arc with about 500 V and 10 mA. Additionally, the signal a microwaves with 10s frequency was allowed to traverse through the hydrogen gas. The suitable materials which are vulnerable to nuclear transmutation when exposed to a neutron flux, were placed exterior of the chamber. Following exposures of the order of days or weeks, the experimentalists reported nuclear transmutations that were based on the observed neutron counts of up to 104 cps.

Note that experiment made no claim of direct detection of neutrons. The detection of neutrons via nuclear transmutations had been reported. This test was not conducted with the neutron detector as it was not available at that time. Therefore, it was very clear that the synthesis of neutrons was indirect evidence, secondarily created and detected via nuclear transmutations. The intermediate particle synthesized in this experiment was reported as "neutriod". Latter, isomathematics and isomechanics also predict the existence of "neutriod" (an intermediate state prior to the neutron synthesis), and denoted by symbol $\tilde{n}$.

Neutriod is the state of singlet coupling of a proton and an electron at 10^{-13} cm caused by the strong Coulomb attraction (which is of the order of 10^{22} N at the indicated mutual distance) as well as by the strong attraction caused by deep mutual penetration of the wavepackets

$$p^+_\uparrow + e^-_\downarrow \longrightarrow \tilde{n} \tag{59}$$

The neutroid is a new particle with; null charge; null spin; null magnetic moment (in first approximation); rest energy

$$\begin{aligned} E_{\tilde{n}} = m_p + m_e - \mathrm{BE} &= 938.2721 + 0.511 - 0.009 \\ &= 938.7741\mathrm{MeV} = 1.008091\mathrm{amu}; \end{aligned} \tag{60}$$

charge radius, $R_{\tilde{n}} = 10^{-13}$cm and estimated mean life, $\tau_{\tilde{n}} = 9$s decipher into a neutron under the availability of the needed 0.782 MeV energy as

$$\tilde{n} \longrightarrow n + \nu \tag{61}$$

and in the absence of said missing energy, it decays as

$$\tilde{n} \longrightarrow p^+ + e^- \tag{62}$$

It is observed that due to thermal energy of DC arc between the electrodes, hydrogen gas molecules broken into H-atoms and then soon converted into H-ions. This process led to a formation of a plasma composed of protons and electrons. Within the plasma the approach of an electron and a proton along the tangent of local magnetic lines with opposite charges, opposing magnetic polarities and opposing spins are needed to form neutroid (**Figure 8, 9**). The realization of Rutherford's "compression" [1] of protons and electrons, one against the other, caused by the disconnection of a rapid DC

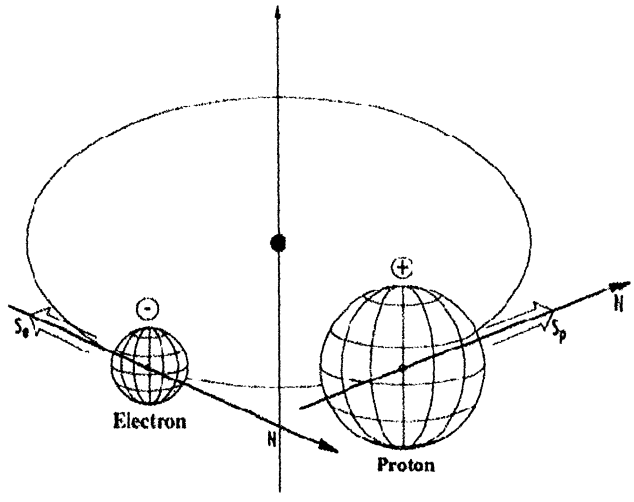


Figure 8: Alignment of proton and electron plasma along the tangent to a local magnetic field

discharge, its activation essentially creating the indicated plasma of protons and electrons. Note that, when inspected in an oscilloscope at the millisecond scale, DC discharges with constant voltage (CV) and constant current (CC) are continuously disconnected and reconnected. Therefore, CV, CC and DC arcs submerged in hydrogen with voltage and energy values beyond their threshold to trigger the process of synthesis of the neutrons (**Figure 9**). Note that, even though the neutrons and neutroids are both neutral and have essentially the same size, neutroids cannot be detected by available neutron detectors because they have different spins, different rest energies, different magnetic moments, and different mean lives. Therefore, neutroids can be solely detected via the analysis of the transmutations, such as via the delayed detection of neutrons, electrons, gammas and other radiations [27]-[32].

It appears that all original tests by E. J. Sternglass, E. Trounson, Don Borghi, as well as the initial tests by R. M. Santilli below the indicated threshold values of voltage and energy [5], synthesized neutroids, rather than neutrons due to the energy of DC arc being insufficient to supply the missing 0.782 MeV and several other reasons identified later on. The above view implies that the nuclear transmutations detected by the original tests were

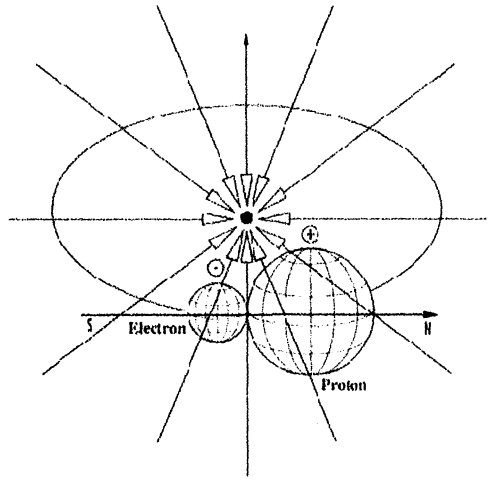


Figure 9: An appropriate alignment for a protons and an electron within the plasma, caused by rapid DC discharge

caused by the absorption of neutroids by natural elements, their consequential instability and subsequent delayed transmutations into new elements.

All possible nuclear transmutation reactions by neurtoids with the heavier elements discuss in the following section.

4 Theoretical Aspects

4.1 Basic Assumptions

In this section, we review the conventional activation of tabulated nuclide [42] via a neutron flux and present the corresponding activation via a flux of neutroids as is necessary for their experimental verification. We shall represent nuclides with the known symbols (Z, A, J), where Z represents the atomic number, A represents the atomic mass, and J represents the angular momentum. The mass of nuclides are ignored since we shall be dealing with tabulated decays emitting energy [39]. Under the assumed notation, nuclides N shall be written $\mathrm{N}(Z, A, J)$ and the related data assumed from Table [43]. For convenience, we shall assume the same notation for neutrons

and neutroids

$$n = n(0,1,1/2), \qquad \tilde{n} = \tilde{n}(0,1,0). \tag{63}$$

as well as for other particles participating in nuclear transmutations, such as

$$\beta^-(1,0,1/2), \quad \nu(0,0,1/2), \quad \gamma(0,0,1). \tag{64}$$

$$EC = EC(-1,0,1/2), \tag{65}$$

where EC denotes Electric Capture, for which the value $Z = -1$ indicates its absorption which implies the decrease of atomic number by one unit due to the neutron synthesis while the value $J = +1/2$ denotes the increase of the nuclear spin by $1/2$. Corresponding to emission of particles, atomic numbers, atomic masses and spins should be subtracted from the original values.

4.2 Activation Mechanism of Neutron and Neucleoid

Neutron activations of tabulated nuclides N [37] follow the well-known rules (see e.g., tabulated data [43])

$$\mathrm{N}(Z,A,J) + n(0,1,1/2) \longrightarrow \mathrm{N}^0(Z,A+1,J+1/2), \tag{66}$$

where N^0 is a known, generally unstable nuclide [37] and the possible chain of decays into a final stable isotope are equally well known [43]. Neutroid activations of a tabulated nuclide N are predicted to follow the new rules

$$\mathrm{N}(Z,A,J) + \tilde{n}(0,1,0) \longrightarrow \tilde{\mathrm{N}}(Z,A+1,J), \tag{67}$$

where $\tilde{\mathrm{N}}$ denotes generally unstable and untabulated nuclides first introduced [29] under the name of nucleoids. When $\tilde{\mathrm{N}}$ is sufficiently excited to release the missing energy of 0.782MeV for synthesis (61), the nucleoid is predicted to have the nuclear transmutation

$$\tilde{\mathrm{N}}(Z,A+1,J) \longrightarrow \mathrm{N}^0(Z,A+1,J+1/2) + \nu(0,0,1/2), \tag{68}$$

where $\mathrm{N}^0(Z,A+1,J+1/2)$ is a tabulated nuclide with known decay. When nucleoid $\tilde{\mathrm{N}}$ does not have the needed missing energy, it decays according to Eq.(62) with following transmutation

$$\tilde{\mathrm{N}}(Z,A+1,J) \longrightarrow \mathrm{N}^0(Z+1,A+1,J+1/2) + \beta^-(1,0,1/2), \tag{69}$$

where $N^0(Z+1, A+1, J+1/2)$ is a tabulated nuclide with known decay of the type

$$\tilde{N}(Z+1, A+1, J+1/2) \longrightarrow N"(Z+1, A+1, J) + \nu(0, 0, 1/2), \qquad (70)$$

There are numerous such transmutation and decay sequences can be possible. Due to the lack of existence of detectors capable of directly detecting neutroids, the sole way known to detect neutroids is given by: 1) Setting up TEC-TNS below the threshold values of 3kV and 1J; 2) Assuring via conventional detectors the lack of neutron emission; and 3). Seeking nuclear transmutations of type (67)-(70) via neutron, electron, gamma delayed emission or spectroscopic analysis of the original and of the irradiated sample.

4.3 Activation of Ag(47, 107, 1/2)

The conventional neutron activation of $Ag(47, 107, 1/2)$ is given by [43]

$$\begin{aligned} Ag(47, 107, 1/2) + n(0, 1, 1/2) &\longrightarrow Ag(47, 108, 1) \\ \longrightarrow Cd(48, 108, 0)[\text{stable isotope}] + e^-(-1, 0, 1/2) &+ \nu(0, 0, 1/2) \end{aligned} \qquad (71)$$

resulting in the stable nuclide $Cd(48, 108, 0)$ is well known. The predicted neutroid activation of $Ag(47, 108, 1/2)$ is given by

$$Ag(47, 107, 1/2) + \tilde{n}(0, 1, 0) \longrightarrow \tilde{Ag}(47, 108, 1/2) \qquad (72)$$

where $\tilde{Ag}(47, 108, 1/2)$ is a nuclideoid because it is untabulated (due to the spin $1/2$) In the event the nucleoid $\tilde{Ag}(47, 108, 1/2)$ is sufficiently excited to trigger synthesis (61), we have the decay

$$\tilde{Ag}(47, 108, 1/2) \longrightarrow Ag(47, 108, 1) + \nu(0, 0, 1/2) + \gamma(0, 0, 1) \qquad (73)$$

where $Ag(47, 108, 1)$ is a stable nuclide and we have used our assumption on the sign of emitted particles.

Note that E. J. Sternglass suggested the apparent synthesis of neutrons from the detection of β emitted from his reactor [5]. Since his equipment did not have sufficient energy to supply the missing energy of 0.782 MeV for the neutron synthesis, it appears that J. Sternglass might have detected a transmutation of type (71) caused by neutroid activation.

Under the assumption that the nucleoid is not in such an excited state to trigger synthesis $\tilde{\text{Ag}}(47, 108, 1/2)$ is predicted to decay along (62)

$$\tilde{\text{Ag}}(47, 108, 1/2) \longrightarrow \text{Cd}(48, 108, 0) + \beta^-(1, 0, 1/2) \tag{74}$$

where the resulting stable nuclide $\text{Cd}(48, 108, 0)$ is the same as for the conventional neutron irradiation, eq.(72).

Intriguingly, E. J. Sternglass reported to A. Einstein the emission of electrons similar to decay (74), while his experimental set up did not have sufficient energy to synthesize neutrons, thus confirming that he synthesized neutroids. A third possible decay is given by

$$\tilde{\text{Ag}}(47, 108, 1/2) + EC(-1, 0, 1/2) \longrightarrow \text{Pd}(46, 108, 0) + \gamma(0, 0, 1) \tag{75}$$

where $\text{Pd}(46, 108, 0)$ is a stable, hence tabulated isotope

4.4 Activation of Ag(47, 109, 1/2)

The conventional neutron activation is given by

$$\begin{aligned} &\text{Ag}(47, 109, 1/2) + n(0, 1, 1/2) \longrightarrow \text{Ag}(47, 110, 1) \\ &\longrightarrow \text{Cd}(48, 110, 0) + \beta^-(1, 0, 1/2) + \nu(0, 0, 1/2) \end{aligned} \tag{76}$$

resulting the stable nuclide $\text{Cd}(48, 110, 0)$, as well known. The predicted neutroid is given by

$$\tilde{\text{Ag}}(47, 109, 1/2) + \tilde{n}(0, 1, 0) \longrightarrow \tilde{\text{Ag}}(47, 110, 1/2) \tag{77}$$

where $\tilde{\text{Ag}}(47, 110, 1/2)$ is an un-tabulated nucleoid with first possible decay under synthesis of (61)

$$\tilde{\text{Ag}}(47, 108, 1/2) + EC(-1, 0, 1/2) \longrightarrow \text{Pd}(46, 110, 0) + \gamma(0, 0, 1) \tag{78}$$

or alternative decay according to neutroid decay (62)

$$\tilde{\text{Ag}}(47, 110, 1/2) \longrightarrow \text{Cd}(48, 110, 0) + \beta^-(-1, 0, 1/2), \tag{79}$$

and there are several endless such decays can be reproduced with other elements also.

4.5 Activation of Au(79, 197, 3/2)

The conventional neutron activation is given by

$$\begin{aligned} \mathrm{Au}(79,197,3/2)+n(0,1,1/2) &\longrightarrow \mathrm{Au}(79,198,2) \\ \longrightarrow \mathrm{Hg}(80,198,0)+\beta^{-}(1,0,1/2)+\nu(0,0,1/2)+\gamma(0,0,1) & \end{aligned} \tag{80}$$

resulting in the stable nuclide Hg(80, 198, 0), as well known. The predicted neutroid activation is given by

$$\mathrm{Au}(79,197,3/2)+\tilde{n}(0,1,0) \longrightarrow \tilde{\mathrm{Au}}(79,198,3/2), \tag{81}$$

where $\tilde{\mathrm{Au}}(79,198,3/2)$ is a nucleoid with decay predicted along synthesis (61) although without the emission of a neutrino

$$\tilde{\mathrm{Au}}(79,198,3/2) \longrightarrow \mathrm{Pt}(78,198,0)+\beta^{-}(1,0,1/2)+\gamma(0,0,1), \tag{82}$$

because the emission of a neutrino as requested by synthesis (61) would yield the inconsistent decay

$$\begin{aligned} \tilde{\mathrm{Au}}(79,198,3/2) \longrightarrow \mathrm{Hg}(80,198,0)+\nu(0,0,1/2) & \\ +\beta^{-}(1,0,1/2)+\gamma(0,0,1). & \end{aligned} \tag{83}$$

An alternative decay is given by

$$\tilde{\mathrm{Au}}(79,198,3/2) \longrightarrow \mathrm{Hg}(80,198,0)+\beta^{-}(1,0,1/2)+\gamma(0,0,1), \tag{84}$$

resulting again in the same stable nuclide Hg(80, 198, 0) as that released by neutron activation without the possibility of consistently admitting the emission of a neutrino. The study of additional virtually endless neutroid activations is left to the interested reader.

5 Experimental Verifications

In past, Ernest J. Sternglass (1951), E. Trounson (1952), and Don Carlo Borghi and his associates (1960) were independently carried out the experiments on synthesis of neutrons from a hydrogen gas. None of the above reported the direct evidence neutron formation in their experiments. They claimed that the neutrons detection was indirect, through nuclear transmutation of intermediate species (called neutroids). However, the claim of

secondarily creation of nuetrons by these researchers has been strongly criticized by academia on pure theoretical grounds without the actual repetition or legitimate analysis of the tests. To verify the claim of above experiments, R. M.Santilli repeated this test carefully considering all mathematical, theoretical and experimental aspects of the production of neutron from hydrogen gas. We have already discussed Santilli's mathematical and theoretical aspects in above sections. Now we are discussing his rigorous experimentations on neutron synthesis.

5.1 Santilli's Experiment on the Synthesis of Neutrons

Santilli conceived his experiment [27]-[30] as being solely based on the use of an electric arc within a cold (i.e., at atmospheric temperature) hydrogen gas without any use of microwave at all. According to experimental conditions, Different type of klystrons were manufactured, tested and used for the measurements. The finer details of these experiments are discussed in follwing sections.

The first direct detection of the synthesis of neutrons from a hydrogen gas was achieved by R. M. Santilli in 2006 [27]-[30]. Tests [27]-[30] were first done with the experimental set up of **Figure 10** comprising: a vertical reactor fabricated from a translucent PVC pipe of 3" diameter and 12" length filled up with a commercially available hydrogen gas at a maximum of 10psi; a 5kW DC welder produced by Miller Electric delivering an electric arc between submerged tungsten electrodes of 1/3" diameter with 20V and 200A; and various neutron and gamma detectors, by Ludlum, Berkeley Nucleonics and Polimaster with internal recording of data. This first experimental set up did not produce neutrons, but produced neutroids due to the steady character of the DC arc. In fact, tests essentially produced transmutations of natural elements surrounding the reactors, at times delayed up to 15 minutes. Tests were also done with the equipment of **Figure 11** comprising: a high-pressure metal reactor of 1 diameter and 2 length containing hydrogen gas up to 100 psi; a DC welder produced by Miller Electric with up to 50kW used to deliver an arc between carbon electrodes (because tungsten electrodes would instantly melt at the power here considered) of about 30 V and 1,000 A corresponding to 30 KVA; and the same neutron detectors of the preceding tests. The tests produced such a high neutron alarms, particularly at the activation and disconnection of the arc, which led to rapid evacuation of the laboratory, as illustrated by the data of **Figure 12** (see Ref. [30] for

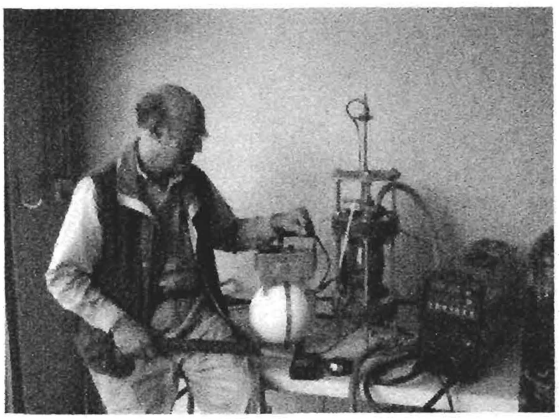


Figure 10: First experiment (2006) on synthesis of neutron from hydrogen gas by Santilli with a vertical reactor fabricated from a translucent PVC pipe

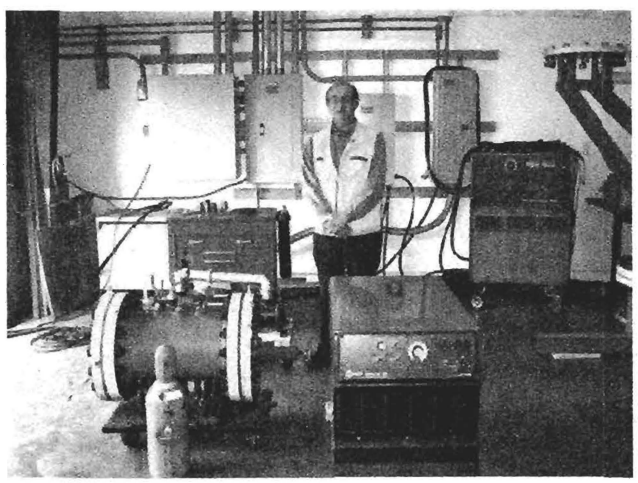
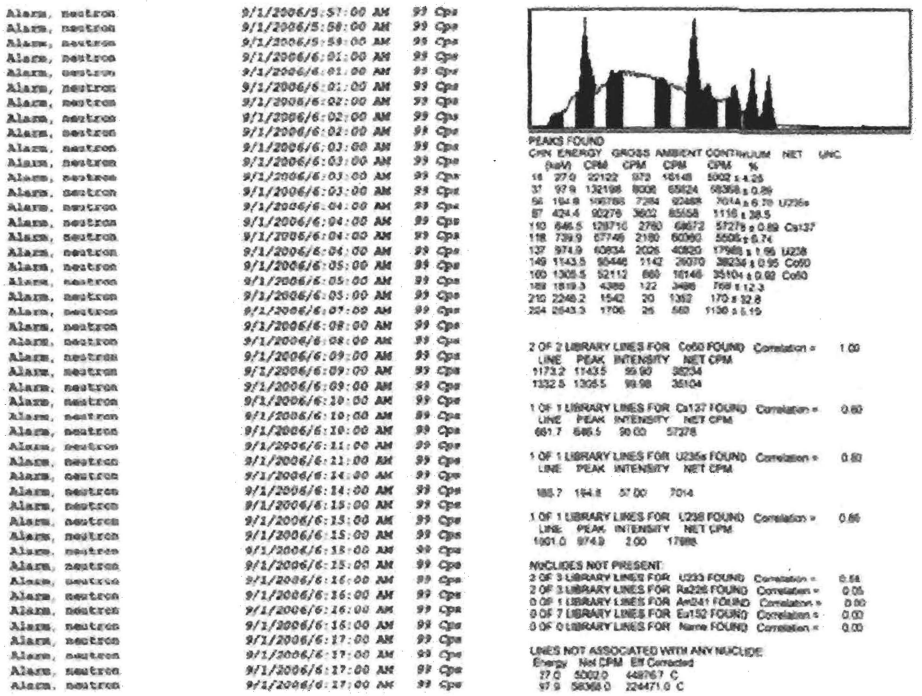


Figure 11: Experiment with a high pressure metal reactor containing hydrogen gas up to 100 psi

comprehensive data). In view of this incidence, no further tests have been done with the hydrogen gas at 100psi for safety reasons.

The third tests were done in 2014 [31, 32] with the setup of **Figure 13** comprising: a reactor fabricated from a translucent PVC pipe of 6": diameter and 24" length containing a commercially available hydrogen gas at a maximum of 30psi; a high voltage 3kW power source supplied by Information


Alarm, neutron 9/1/2006/5:57:00 AM 99 Cps
Alarm, neutron 9/1/2006/5:58:00 AM 99 Cps
Alarm, neutron 9/1/2006/5:59:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:01:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:01:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:01:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:02:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:02:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:02:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:03:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:03:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:03:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:03:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:04:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:04:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:04:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:04:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:05:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:05:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:05:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:07:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:08:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:08:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:09:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:09:00 AM 99 Cps
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Alarm, neutron 9/1/2006/6:10:00 AM 99 Cps
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Alarm, neutron 9/1/2006/6:10:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:11:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:11:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:14:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:14:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:15:00 AM 99 Cps
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Alarm, neutron 9/1/2006/6:15:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:15:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:16:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:16:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:16:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:16:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:17:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:17:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:17:00 AM 99 Cps
Alarm, neutron 9/1/2006/6:17:00 AM 99 Cps
PEAKS FOUND
CHN ENERGY GROSS AMBIENT CONTINUUM NET UNC.
(keV) CPM CPM CPM CPM %
16 27.0 22122 972 16148 5002 ± 4.25
37 97.9 132198 8008 65624 58366 ± 0.89
56 194.8 190780 7284 92488 7014 ± 6.70 U235e
87 424.4 90279 3602 85658 1116 ± 38.5
110 646.5 128710 2760 68672 57275 ± 0.89 Cs137
118 739.9 67746 2180 60060 5506 ± 6.74
137 974.9 60834 2026 40820 17988 ± 1.66 U238
149 1143.5 95446 1142 26070 38234 ± 0.95 Co60
160 1305.5 52112 660 16146 35104 ± 0.92 Co60
169 1619.3 4380 122 3488 769 ± 12.3
210 2246.2 1542 20 1362 170 ± 32.8
224 2643.3 1706 25 569 1136 ± 5.19
2 OF 2 LIBRARY LINES FOR Co60 FOUND Correlation = 1.00
LINE PEAK INTENSITY NET CPM
1173.2 1143.5 99.90 38234
1332.5 1305.5 99.98 35104
1 OF 1 LIBRARY LINES FOR Cs137 FOUND Correlation = 0.80
LINE PEAK INTENSITY NET CPM
661.7 646.5 90.00 57278
1 OF 1 LIBRARY LINES FOR U235e FOUND Correlation = 0.80
LINE PEAK INTENSITY NET CPM
185.7 194.8 57.00 7014
1 OF 1 LIBRARY LINES FOR U238 FOUND Correlation = 0.66
LINE PEAK INTENSITY NET CPM
1001.0 974.9 2.00 17988
NUCLIDES NOT PRESENT
2 OF 3 LIBRARY LINES FOR U233 FOUND Correlation = 0.58
2 OF 3 LIBRARY LINES FOR Ra226 FOUND Correlation = 0.05
0 OF 1 LIBRARY LINES FOR Am241 FOUND Correlation = 0.00
0 OF 7 LIBRARY LINES FOR Eu152 FOUND Correlation = 0.00
0 OF 0 LIBRARY LINES FOR None FOUND Correlation = 0.00
LINES NOT ASSOCIATED WITH ANY NUCLIDE
Energy Net CPM Eff Corrected
27.0 5002.0 448767 C
97.9 58368.0 224471.0 C

Figure 12: Result of high pressure reactor, produces loud neutron alarm which led to rapid evacuation of the laboratory

Unlimited of New Hampshire, depicted in **Figure 14**, delivering a sequence of rapid DC arcs between submerged, 1" diameter carbon electrodes with up to 15kV and up to 2,500J when connected to a 20μF capacitor; and various neutron-gamma detectors with internal recording of all detections, including a SAM 935 by Berkeley Nucleonics, a PM1703 by Polimaster, and other detectors.

The reactor was fabricated in translucent PVC so as to allow visual inspection of the working setup filled with air, then filling up of the reactor with hydrogen, activating and disconnecting the reactor at a distance, and downloading data on neutrons and gamma CPS from the memory banks of the detectors. Tests [31, 32] established the controlled synthesis of neutrons from a hydrogen gas with an industrially valuable flux with up to 1.9 neutron CPS corresponding to about 4,500CPS when pro-rated to the sphere centered in the arc. Tests [31, 32] also established the thermal character of the synthesized neutrons due to lack of energy from the plasma surrounding

Figure 13: The third experiment (2014) on synthesis of neutron with reactor fabricated from a translucent PVC pipe containing commercially available hydrogen gas at 30 psi

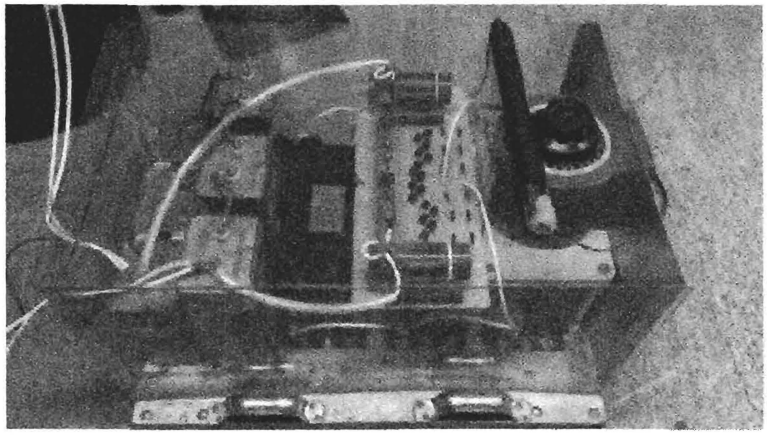


Figure 14: A high power supply of 3kW made by Information Unlimited, New Hampshire

the arc which was insufficient to create high-energy motion perpendicular to the arc. In this paper, we report the following tests:

Test 1: This was done with the experimental set up of **Figure 15** comprising: the same power source as that of tests [31, 32] (**Figure 14**) charging six capacitors for a total of 10μF; the Ludlum 375 and SAM 940 neutron

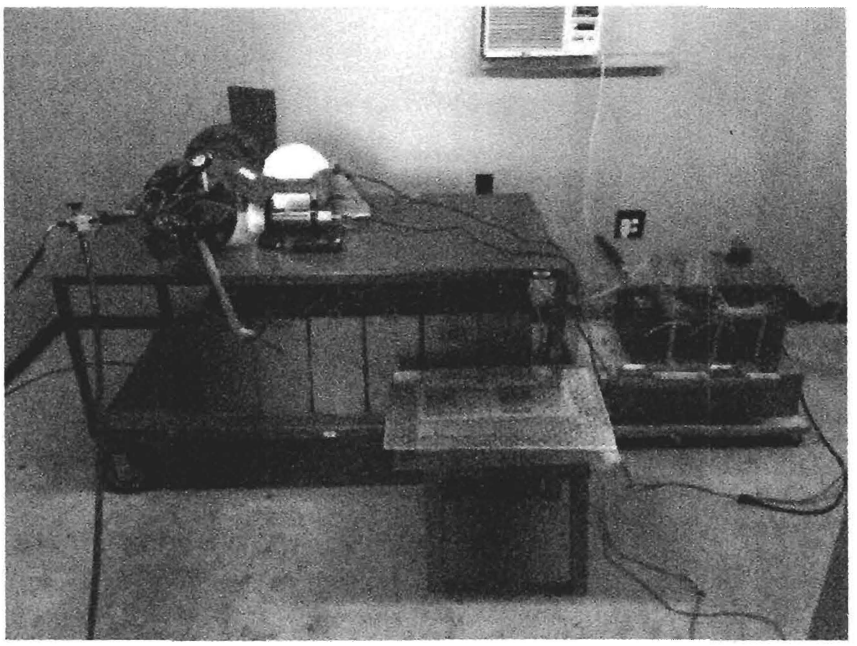


Figure 15: A complete set up of third experiment: Test 1

and gamma detector; the reactor depicted in **Figure 16** showing the remote controlled stepper motor (on the left), the internal electrodes and various valves; and the remote control station depicted in **Figure 17** comprising from the right, control the gap between the electrodes, the main switch to activate the power source the neutron and gamma remote Ludlum sensors and the Polimaster PM1703 to verify the lack of harmful radiation at the remote control station for the safety of the operator. Some of the neutron CPS detected by the Ludlum 375 are depicted in the left of **Figure 18**, and the confirmation of neutron detected by the SAM 940 is depicted in the right (see also Ref. [44] for a short movie on these tests).

Test 2: Done with the experimental set up of **Figure 19** known as the Thermal Neutron Source (TNS) 20 comprising: the same reactor of **Figure 16** and the same high voltage power source of **Figure 14** used in preceding tests, the latter being connected of rapid discharge capacitors with 20μF supplied by General Atomic of San Diego, California; the Ludlum 375, SAM 940 and Polimaster PM1704 neutron and gamma detectors with position of their sensors illustrated in **Figure 20**; the remote control station illustrated

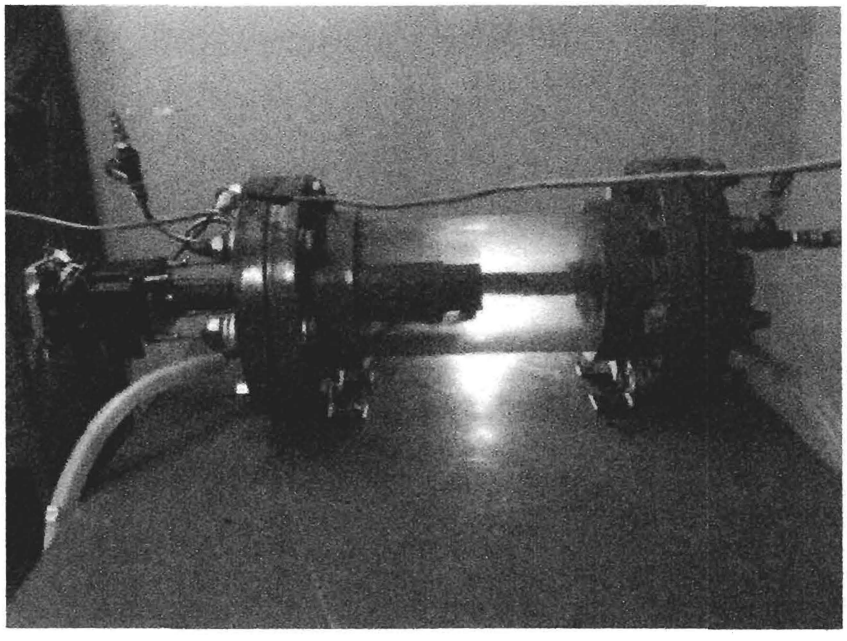


Figure 16: The remote controlled stepper motor, the internal electrodes and valves

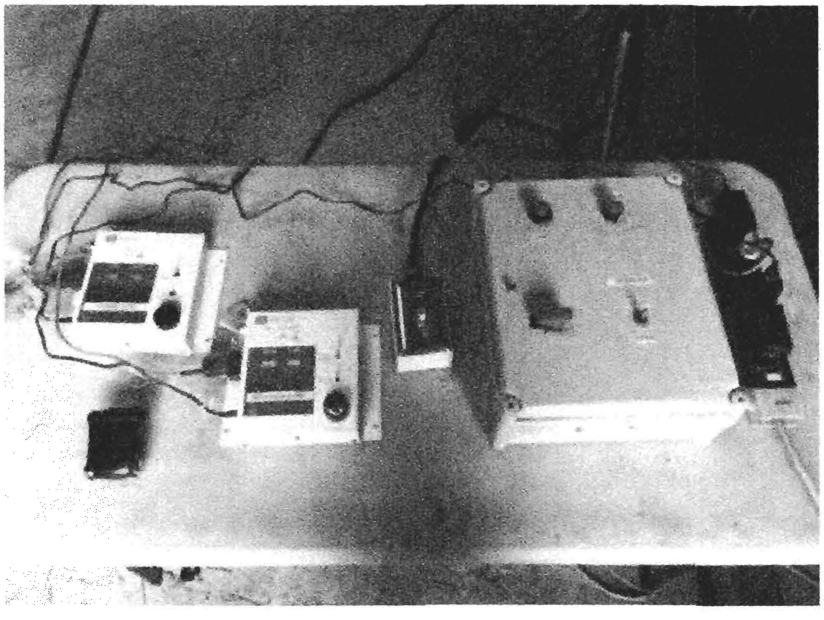
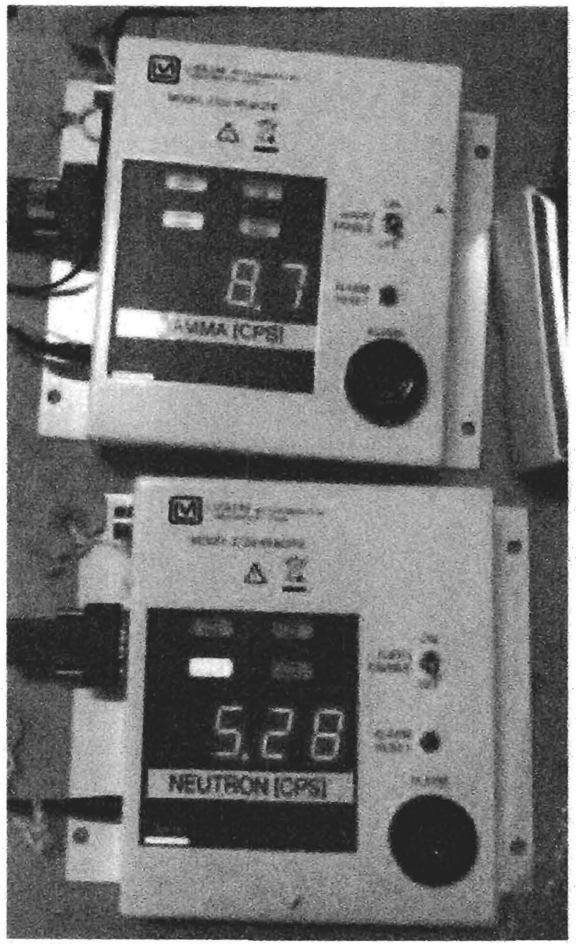


Figure 17: The remote controlled station



Readout from Polimaster PM1704GN

12:19:20 AM	Gamma background	4 μR/h
12:19:20 AM	Neutron background	0.02 cps
1:19:20 AM	Gamma background	4 μR/h
1:19:20 AM	Neutron background	0.02 cps
2:19:20 AM	Gamma background	4 μR/h
2:19:20 AM	Neutron background	0.02 cps
3:19:20 AM	Gamma background	4 μR/h
3:19:20 AM	Neutron background	0.02 cps
4:19:20 AM	Gamma background	4 μR/h
4:19:20 AM	Neutron background	0.02 cps
5:19:20 AM	Gamma background	4 μR/h
5:19:20 AM	Neutron background	0.02 cps
6:19:20 AM	Gamma background	4 μR/h
6:19:20 AM	Neutron background	0.02 cps
7:19:20 AM	Gamma background	5 μR/h
7:19:20 AM	Neutron background	0.02 cps
7:46:20 AM	**Neutron alarm**	**0.02 cps**
8:19:20 AM	Gamma background	4 μR/h
8:19:20 AM	Neutron background	0.02 cps
9:19:20 AM	Gamma background	4 μR/h
9:19:20 AM	Neutron background	0.02 cps
10:17:58 AM	**Neutron alarm**	**0.02 cps**
10:19:20 AM	Gamma background	5 μR/h
10:19:20 AM	Neutron background	0.02 cps
11:19:20 AM	Gamma background	4 μR/h
11:19:20 AM	Neutron background	0.02 cps
11:47:20 AM	**Neutron alarm**	**0.02 cps**
12:19:20 PM	Gamma background	3 μR/h
12:19:20 PM	Neutron background	0.02 cps
1:19:20 PM	Gamma background	3 μR/h
1:19:20 PM	Neutron background	0.01 cps

Figure 18: The neutron CPS detected by Ludlum 375 (left) and the confirmation of neutron detected by the SAM 940 (right)

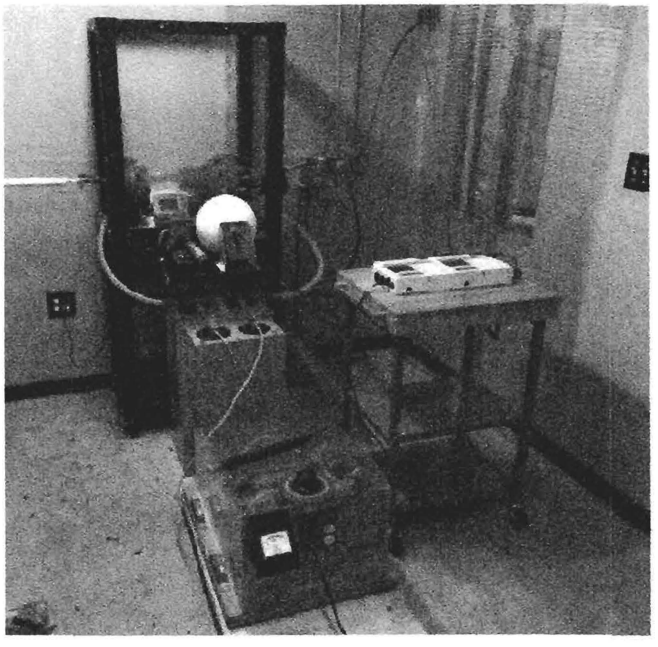


Figure 19: Experimental set up of Test 2

in **Figure 21** comprising from the right and the remote control of the stepper motor to achieve the desired gap between the carbon electrodes, the main switch to activate the power source; the Ludlum remote sensors for neutron and gamma CPS; and the remote control of the power used in the power source. A number of neutron CPS detected during these tests are presented in Section 5.2 and 5.3.

Test 3: The same experimental set up as that of Tests 2 with the high voltage power source of up to 20kV and 5kW delivering a rapid DC discharge between the submerged electrodes of up to 3,000J following the charge of capacitors with 20μF (see **Picture 22** showing in front-right the 5kW high voltage power source).

Test 4: the same experimental set up of Tests 3 with the Magna-Power source, model XR10000-0.80/480POS+LXI with 8kW, 10kV and 0.8A. During the tests, the source was set at 8kV and 0.5A, but operated with voltage oscillating between 2.5kV and 0.5A, with a rapid rate of charging the capacitors at about 3 discharges per second, that resulted in an essentially steady production of 4 to 6 neutron CPS (see **Figure 22** showing in front-left the

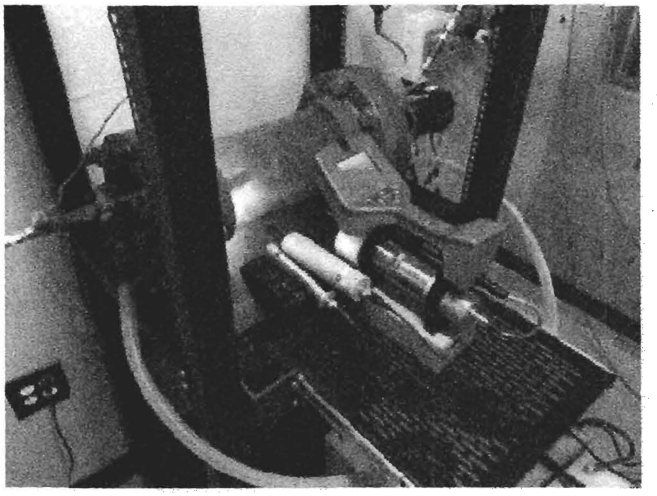


Figure 20: Ludlum 375, SAM 940, Polimaster PM1704 neutron and gamma detectors with position of their sensors

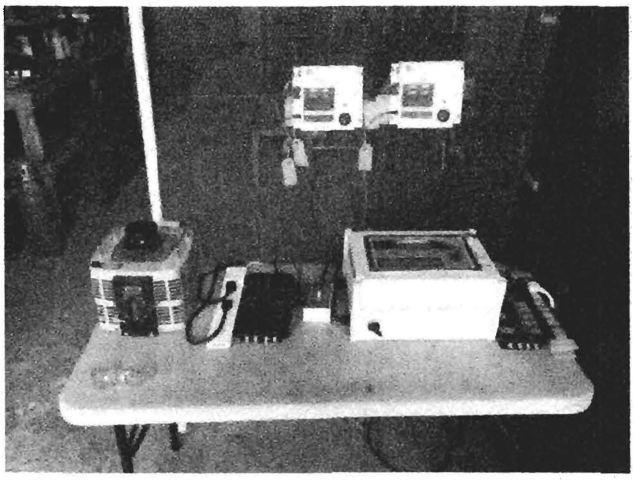


Figure 21: Remote controlled station of Test 2

Figure 22: Set up of Test 3 with high voltage power source up to 20kV

8kW high voltage Magna-Power source). **Test 5**: The same experimental set up of Tests 3 but with the power source supplied by Information Unlimited directly connected to the arc without capacitors (the Magna Power source could not be used because of its automatic disconnect when used to deliver DC arcs). The various tests were done according to the following written routine: verification that all switches are off and the capacitors are discharged; flushing the reactor with air from a compressor to remove hydrogen residues; selection of the desired power; consequential selection of the gap between the electrodes; remote activation of the power unit; verification of the existence of acceptable arc in air; disconnection of all switches and verification that the capacitors are discharged; flushing the reactor with hydrogen; setting up the desired hydrogen pressure in the reactor; activate cameras filming the reactor as well as the remote sensors; activate remotely the TNS; conduct the test for the desired duration of time; disconnect all switches; move the electrodes into a short to discharge residual charges; verification that the capacitors are indeed discharged; and collect neutron and gamma CPS from the Ludlum 375, the SAM 940 and the Polimaster PM1704.

5.2 Experimental Confirmation of Neutroid

The reactor (TNS) is working with low power, as we don't want to synthesize neutrons, but only neutroids which require lower energies. No neutron detection should occur during the test, but readings are expected sometime after the arc has been turned off, due to the decay of the nuclei made unstable by the neutroids themselves. These neutron emissions are expected to be very directional and random, so the detectors are not likely to see them at the same time. The experimental results obtained are reported in **Table 1**.

Table 1: Neutroid test

Summary of Neutroids Test	
Test 1-Reactor filled with H_2 at 1 atm	Power set at 0.75kW,
Start Time	11.23 am
End Time	11.27 am
Ludlum Neutron Detections during test	None
Ludlum Gamma Detections (CPS)	11.6, 8.8, 10.7, 12.9, 13.8, 14.1 (coherent with background)
Ludlum Neutron Detections after the end	1 CPS 4 minutes later
SAM Neutron Detections	0 CPS 4 min latter
SAM Gamma Detections	43.9633
Test 2 - Same Configuration as previous	
Start Time	1.40 am
End Time	1.44 am
Ludlum Neutron Detections during test	None
Ludlum Gamma Detections during test	coherent with background
Ludlum Neutron Detections after the end	None
SAM Neutron Detections (CPS)	0.0033 CPS, 1 counts
SAM Gamma Detections (CPS)	44.3733 CPS
Test 3 - Same Configuration as previous	
Start Time	1.50 am
End Time	1.55 am
Ludlum Neutron Detections during test	None
Ludlum Gamma Detections during test	coherent with background
Ludlum Neutron Detections after the end	1 CPS 30 sec latter
SAM Neutron Detections (CPS)	0.0017 CPS, 0 counts
SAM Gamma Detections (CPS)	44.995 CPS

Continuation of Table 1	
Test 4 - Same Configuration as previous	
Start Time	2.04 am
End Time	2.10 am
Ludlum Neutron Detections during test	None
Ludlum Gamma Detections during test	coherent with background
Ludlum Neutron Detections after the end	None
SAM Neutron Detections (CPS)	0 CPS, 0 counts
SAM Gamma Detections (CPS)	47.7433 CPS
Test 5- Reactor with H_2 at 10 psi	Power set at 0.75kW
Start Time	2.25 am
End Time	2.30 am
Ludlum Neutron Detections during test	None
Ludlum Gamma Detections during test	coherent with background
Ludlum Neutron Detections after the end	1 CPS, 1 min latter
SAM Neutron Detections (CPS)	0.005 CPS, 3 counts
SAM Gamma Detections (CPS)	44.6533 CPS

5.3 Experimental Confirmation of the Synthesis of Neutron

The reactor (TNS) is working with different power units and various levels of power. Two power units designed adhoc by Information Unlimited and one commercially available by MagnaPower have been used. The pressure of hydrogen inside the reactor has been used as a variable as well, changing it in a controlled way to verify the effects on neutron CPS. It should be noted that the Ludlum detector provides a real-time record of the neutron and gamma counts, while the SAM940 detector only records an average neutron and gamma CPS for the entire duration of the test. The neutron CPS values reported for the Ludlum in the tests with the two Information Unlimited power units (see **Tables 2-3**) are just the peak values corresponding to the capacitors discharge, which typically happen every 5 seconds. The typical shape of neutron emission during test time can be seen in **Figure 23**, together with the trend of power consumption from the unit. During the tests with the MagnaPower unit (see **Table 4**), however, on the other end, the discharges were much quicker, resulting in a continuous neutron production, as can be seen in **Figure 24**, so the values reported in the table do represent the actual

neutron CPS variations recorded by Ludlum detector.

Table 2: Neutron test

Summary of Neutron Test with Information Unlimited Power Unit 1	
Test 1-Reactor filled with H_2 at 5 psi	Power set at 1.5kW, electrode gap at 2.2mm
Ludlum Neutron Detections (CPS)	4.06, 4.06, 4.06, 3.06, 3.05, 3.05, 4.05, 4.05, 4.06
Ludlum Gamma Detections (CPS)	15.6, 11.2, 8.6, 9.0, 10.9, 9.8 (coherent with background)
SAM Neutron Detections (CPS)	0.5444
SAM Gamma Detections (CPS)	46.2611 (coherent with background)
PoliMaster Detection	Neutron Alarm
Test 2-Reactor filled with H_2 at 20 atm	Power set at 2kW electrode gap at 2mm
Ludlum Neutron Detections (CPS)	4.00, 6.00, 5.00, 5.00, 4.00, 5.00, 4.00, 4.00, 4.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 3-Reactor filled with H_2 at 20 psi	Power set at 2kW electrode gap at 2.2mm
Ludlum Neutron Detections (CPS)	4.00, 4.00, 2.00, 5.00, 4.00, 4.00, 4.00, 4.00, 5.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 4-Reactor filled with H_2 at 27 psi	Power set at 2kW, electrode gap at 1.9mm
Ludlum Neutron Detections (CPS)	4.00, 4.00, 4.00, 4.00, 4.00, 5.00, 5.00, 4.5, 4.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 5-Reactor filled with H_2 at 20 psi detector at 2cm from reactor wall	Power set at 2kW electrode gap at 2mm
Ludlum Neutron Detections (CPS)	6.00, 5.00, 5.00, 5.00, 5.00, 5.00, 5.00, 5.00, 5.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 6-Reactor filled with H_2 at 20 psi detector at 1.5cm from reactor wall	Power set at 2kW electrode gap at 2mm
Ludlum Neutron Detections (CPS)	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00

Continuation of Table 2	
Ludlum Gamma Detections (CPS)	coherent with background
Test 7-Reactor filled with H_2 at 15 psi	Power set at 2kW
detector at 2cm from reactor wall	electrode gap at 2mm
Ludlum Neutron Detections (CPS)	4.00, 3.00, 4.00, 4.00,
	4.00, 4.00, 4.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 8-Reactor filled with H_2 at 15 psi	Power set at 2kW,
	electrode gap at 2mm
Ludlum Neutron Detections (CPS)	3.00, 3.00, 2.76, 2.58, 2.64,
	3.33, 3.41, 3.41, 4.20
Ludlum Gamma Detections (CPS)	coherent with background
Test 9-Reactor filled with H_2 at 20 psi	Power set at 2kW,
	electrode gap at 2mm
Ludlum Neutron Detections (CPS)	4.00, 5.00, 5.00, 4.00,
	5.00, 4.00, 5.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 10-Reactor filled with H_2 at 25 psi	Power set at 2kW,
	electrode gap at 1.9mm
Ludlum Neutron Detections (CPS)	5.00, 6.00, 5.00, 5.00, 5.00,
	4.00, 5.00, 6.00, 4.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 11-Reactor filled with H_2 at 30 psi	Power set at 2kW,
	electrode gap at 1.9mm
Ludlum Neutron Detections (CPS)	4.00, 6.00, 5.00, 6.00, 4.00,
	4.00, 5.00, 5.00, 5.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 12-Reactor filled with H_2 at 30 psi	Power set at 2kW,
	electrode gap at 1.8mm
Ludlum Neutron Detections (CPS)	4.00, 4.00, 4.00, 5.00, 4.02,
	4.00, 5.00, 4.00, 5.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 13-Reactor filled with H_2 at 30 psi	Power set at 2kW,
	electrode gap at 1.7mm
Ludlum Neutron Detections (CPS)	2.28, 2.28, 2.28, 2.53, 3.32,
	3.41, 2.42, 2.42, 2.30
Ludlum Gamma Detections (CPS)	coherent with background

Continuation of Table 2	
Test 14-Reactor filled with H_2 at 30 psi	Power set at 2kW, electrode gap at 1.9mm
Ludlum Neutron Detections (CPS)	1.73, 1.42, 1.71, 1.42, 1.71, 1.85, 1.46, 1.36, 1.68
Ludlum Gamma Detections (CPS)	coherent with background

Table 3: Neutron test

Summary of Neutron Test with Information Unlimited Power Unit 2	
Test 1-Reactor filled with H_2 (at 10 psi)	Power set at 3.5kW, electrode gap at 2mm Power set at 4.5kW, electrode gap at 2.2mm
Ludlum Neutron Detections (CPS) (at 3.5 kW)	3.00, 3.05, 3.05, 3.02, 3.02, 3.05, 3.05, 3.02, 3.02
Ludlum Neutron Detections (CPS) (at 4.5 kW)	4.09, 4.05, 3.05, 3.05, 4.05, 3.05, 3.05, 4.02, 3.09
Ludlum Gamma Detections (CPS)	coherent with background
SAM Neutron Detections (CPS)	0.372222
SAM Gamma Detections (CPS)	45.4222
PoliMaster Detection	Neutron Alarm
Test 2-Reactor filled with H_2 at 5 psi	Power set at 2.5kW, electrode gap at 2mm
Ludlum Neutron Detections (CPS)	4.00, 4.00, 4.00, 4.00, 4.00, 4.00, 4.00, 4.00, 4.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 3-Reactor filled with H_2 at 10 psi	Power set at 2.5kW, electrode gap at 2mm
Ludlum Neutron Detections (CPS)	3.01, 3.02, 5.00, 4.00, 4.00, 4.00, 4.00, 5.00, 4.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 4-Reactor filled with H_2 at 20 psi	Power set at 3.5kW, electrode gap at 2mm
Ludlum Neutron Detections (CPS)	5.00, 4.00, 4.00, 4.00, 4.00, 5.00, 5.00, 5.00, 5.00
Ludlum Gamma Detections (CPS)	coherent with background
Test 5-Reactor filled with H_2 at 30 psi	Power set at 3.5kW, electrode gap at 2mm
Ludlum Neutron Detections (CPS)	4.02, 4.01, 5.03, 4.02, 4.01, 4.03, 4.03, 4.03, 4.03
Ludlum Gamma Detections (CPS)	coherent with background

Table 4: Neutron test

Summary of Neutron Test with Magma Power	
Test 24-Reactor filled with H_2 at 10 psi	Power set at 1.5kW and 0.5mA, electrode gap at 2.2mm
Ludlum Neutron Detections (CPS)	3.50, 3.75, 3.94, 3.98, 4.00, 4.00, 4.00, 6.00, 6.01
Ludlum Gamma Detections (CPS)	coherent with background
SAM Neutron Detections (CPS)	0.222222
SAM Gamma Detections (CPS)	47.4778
PoliMaster Detection	Neutron Alarm
Test 25-Reactor filled with H_2 at 1 atm	Power set at 2.5kW and 0.5mA, electrode gap at 2mm
Ludlum Neutron Detections (CPS)	5.12, 6.25, 4.78, 3.39, 3.69, 4.78, 3.92, 2.96, 3.48
Ludlum Gamma Detections (CPS)	coherent with background
SAM Neutron Detections (CPS)	0.366667
SAM Gamma Detections (CPS)	61.1444
Test 26-Reactor filled with H_2 at 10 psi	Power set at 1.5kW and 0.5mA electrode gap at 2.1mm
Ludlum Neutron Detections (CPS)	8.27, 9.08, 12.07, 10.03, 8.01, 12.07, 7.50, 6.25, 9.37
Ludlum Gamma Detections (CPS)	coherent with background
SAM Neutron Detections (CPS)	0.688889
SAM Gamma Detections (CPS)	44.5889
Test 27-Reactor filled with H_2 at 20 psi	Power set at 1.5kW and 0.5mA electrode gap at 1.9mm
Ludlum Neutron Detections (CPS)	4.25, 4.12, 4.06, 4.25, 6.01, 5.01, 4.50, 6.01, 4.12
Ludlum Gamma Detections (CPS)	coherent with background
SAM Neutron Detections (CPS)	N/A
SAM Gamma Detections (CPS)	N/A
Test 28-Reactor filled with H_2 at 30 psi	Power set at 1.5kW and 0.5mA electrode gap at 1.8mm
Ludlum Neutron Detections (CPS)	4.58, 5.29, 4.32, 5.16, 4.58, 5.29, 4.64, 5.32, 4.66
Ludlum Gamma Detections (CPS)	coherent with background

Continuation of Table 4	
SAM Neutron Detections (CPS)	N/A
SAM Gamma Detections (CPS)	N/A

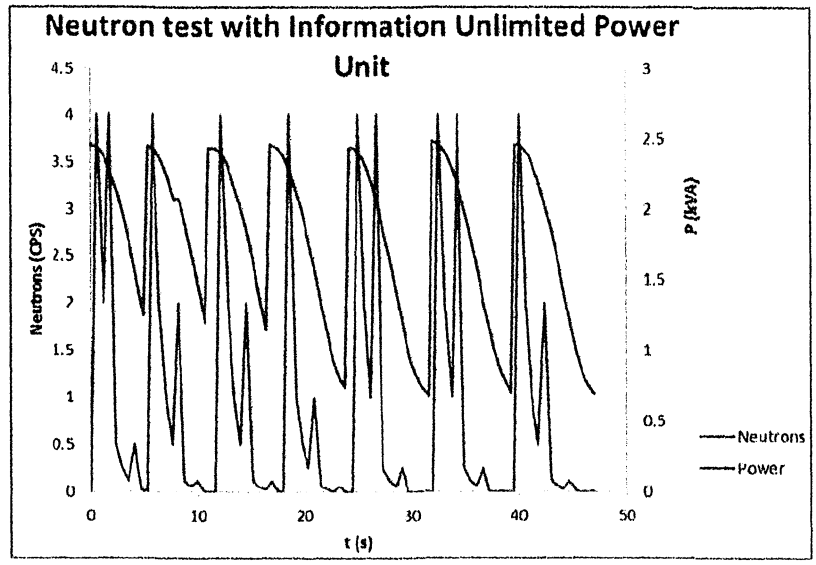


Figure 23: A typical shape of neutron emission during test

6 Santilli's Work in a Nutshell

As reviewed in Section 1, H. Rutherford [1] conceived the neutron in 1920 as a "compressed hydrogen atom" in the core of stars. The existence of the neutron was experimentally verified by J. Chadwick [2] in 1932. However, W. Pauli [3] objected the synthesis of neutron solely from an electron and a proton, on the ground of non-conservation of spin. Latter, E. Fermi [4] developed theory of weak interaction and incorporated the involvement of neutrino in the synthesis of neutron. Recall that, neutrino is massless, unstable particle having spin half.

Incorporation of neutrino led to the birth of thousands of such mysterious hypothetical (quarks or collectively called elementary particles) unstable particles whose lifetime even not detectable and claimed that these particles

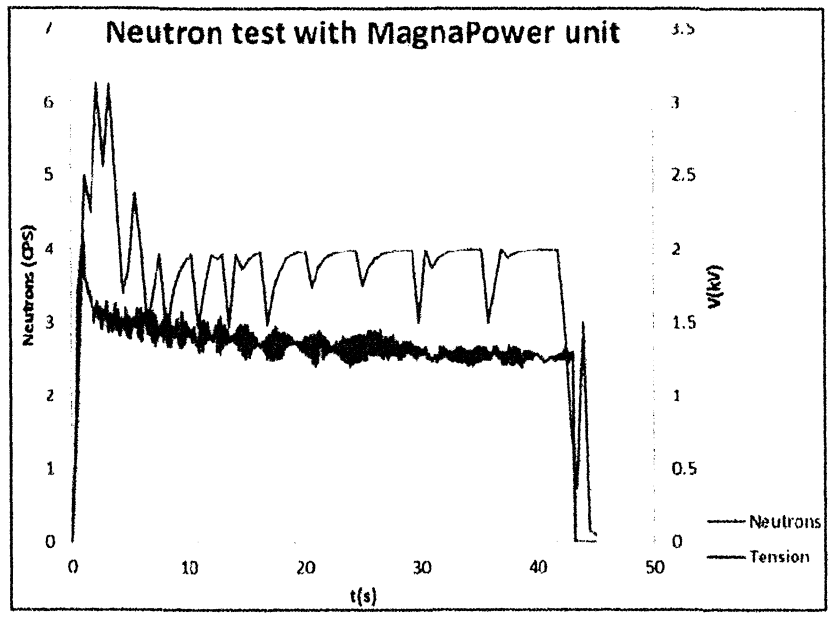


Figure 24: Quicker discharging results continuous neutron production

are the fundamental entities of the universe. Slowly, the quarks philosophy started capturing the scientific minds and now, it is thought that the quarks are the responsible for creation and annihilation of particles in almost every nuclear process. So the case of neutron, it is tried to established that the synthesis of latter is from hypothetical quarks rather than permanently stable particles; proton and electron.

Although people thought (theoretical proposition) that the quarks are the ultimate constituents of matter, but their existence are yet elusive owing to: the lack of detection of quarks at the extremely high energies currently available at CERN; the impossibility of defining quarks as physical particles in our spacetime since they are not representable with the Poincare symmetry; the impossibility of achieving a serious quark confinement, one with an identically null probability of tunnel effects into free particles due to the uncertainty principle, and other problems

Due to dictatorship ruling of quarks, Rutherford's legitimate conjecture of synthesis of neutron from an electron and a proton was suppressed. However, there was some other scientific fraternity who believes in the Rutherford's conjecture and started experimentations to prove it. Prominently, E.

J. Sternglass (1950), E. Trounson (1952), Don Carlo Borghi and his associates (1960) tried the synthesis of neutron from hydrogen gas [5]. None of the above claimed the direct detection of neutron but they predicted that the evidence of delayed nuclear transmutations that could solely be due to a flux of neutrons synthesized by the reactors. They predicted an intermediate, neutron like species with zero spin, called neutriod. Don Carlo Borghi's test implied that the neutron is a conventional, quantum mechanical bound state of a proton and an electron under strong Coulomb attractions. However, their claim was rejected on theoretical ground without repetition of the experiment. The logical supposition of Rutherford and the experimental outcomes of Don Borghi impressed R. M Santilli and in the late 1970's, while being in the faculty of Harvard University under DOE support, he [11]-[14] initiated systematic studies on the neutron synthesis. The systematic progress of Santilli's work on neutron synthesis is given below:

1. He first identified the bound state of hydrogen atom occurs due to Rutherford type compression, in which the electron is completely immersed in hyperdense medium of heavier proton structure at distances of the order of 10^{-13}cm. This bound state (hadronic state) is different than the normal hydrogen atom in which the distance between electron and proton is equal to the Bohr's orbit of the order of 10^{-8}cm. The hadronic bound state is one in which mutual overlapping of wavepackets of an electron and a proton produces a new kind of interaction that is unknown to the conventional quantum mechanics. Therefore, electrons and protons are point like abstractions considered in obtaining a solution of Schrondiger equation is irrelevant for the compressed state. Santilli, further observed that hydrogen atom is the first excited state of hadronic bound state which occurs when electron leaves the proton structure.

2. Santilli's argument is that such an abstraction is certainly acceptable for particles at large mutual distances (exterior dynamical conditions), but it becomes insufficient when extended particles are in conditions of mutual penetration (interior dynamical conditions). Further, due to significant overlapping mutual wavepackets emergence non-linear, non-local and contact non-Hamiltonian type interactions which are simply beyond the ambit of 20th century mathematics for quantitative treatment the problem.

3. In order to have the appropriate representation to solve the problem like compression of hydrogen atom in the synthesis of neutron, Santilli worked out the foundations of the new mathematics, today known as isomathematics and then foundation of isomechanics to solve the real physical problem in which the proton is represented with its actual, experimentally measured dimension and density. With this comprehensive mathematical and physical methods, Santilli achieved the first and only known exact representation of all characteristics of the neutron in its synthesis from a proton and electron at the nonrelativistic and relativistic levels[23]-[26].

4. Based on the understanding of the neutron synthesis achieved via these mathematical and theoretical studies and keeping Don Carlo Borghi's experimental results in mind, Santilli conducted systematic experimental confirmations of the synthesis of neutrons from a hydrogen gas. He rigorously repeated this experiment several times with different practical arrangements such by varying dimensions and material of the reactor, pressure (of the hydrogen gas), power, charging and discharging time sequences, gap between the electrodes, detectors, etc. He successfully detected the production of neutroids and neutrons form hydrogen gas. In Santilli's test it is observed that the neutroids (the intermediate state before actual production of neutrons) synthesized when reactor is operated with low power. However, after the arc has been turned off, neutriods decay into neutrons in random way. It is further observed that when reactor is working relatively at higher power, neutrons are detected by both the detectors employed in the experiment[27]-[34].

5. Subsequently, the U. S. publicly traded company Thunder Energies Corporation (TEC, thunder-energies.com) began production and sale of the Thermal Neutron Sources (TNS) used in the tests, which source can provide on demand the desired flux of low energy neutrons from a commercially available hydrogen gas via the control of the electric power, hydrogen pressure, electrode gap and other engineering means (patent pending).

At large, Santilli's work is a milestone in the particle physics because the outputs generated through his mathematical, theoretical and experimental work can be used as precursor for scientific and industrial development for the

mankind. Some of the endeavors taken up by Thunder Energies Corporation for commercial exploration of santilli's work is given below:

1. The detection of fissionable material that can be smuggled in containers or suitcases via the detection of the radiation emitted by their decay when irradiated by thermal neutrons;

2. The recycling of nuclear waste via their stimulated decay and reduction of their mean lives when activated by a sufficiently strong flux of sufficiently energetic neutrons and other particles;

3. The detection and concentrations in mines of precious minerals and other elements via the detection of the sharp gammas emitted under their irradiation by thermal neutrons irradiation;

4. The treatment of cancerous cells when irradiated by a thin beam of very low energy neutrons;

5. The study of esoenergetic nuclear transmutations without the emission of harmful radiations and without the release of radioactive waste

7 Implications of Santilli's Research

1. A broad implication of isomathematics, isomechanics and experimental confirmation is that structure of the particle (isoparticle as the neutron results to be a generalized bound state of one proton and one electron) rather than the classification of particles. Moreover, 20th century mathematics and sciences unable to provide unique way to classify particles into families.

2. The particles, neutron or neutroid predicted by the isomechanics and detected through experimentation is a bound state of stable particles proton and electron, it cannot be a bound state of mysterious particles, quarks. Hence, in isomechanics there is no place for irrational statement like 'at the time of the neutron synthesis, the permanently stable proton and electron would disappear from the universe to be mysteriously transformed into the hypothetical quarks and, at the time of the neutron spontaneous decay, quarks would disappear from the universe and the permanently stable proton and electron reappear'.

3. Instead of abstraction of proton and neutron as massive particles, their representation as extended, deformable particle has permitted the first and only known numerically exact and time invariant representation of nuclear magnetic moments [31, 32] [37, 38]and spins [39]. The same representation is now applying by Thunder Energies Corporation for initiation of the Intermediate Controlled Nuclear Syntheses (also called "warm syntheses without the emission of harmful radiation and without the release of radioactive nuclear waste ")[45]-[49].

4. Neutron synthesis by Santilli's method have given the characterization of new composites with actual physical constituents and detectable mean lives of the order of seconds, which discard the point-like abstraction and fully consistent under the representation of their constituents as extended particles verifying covering laws (isoparticles). These composites are being suitable for new activations and numerous industrial applications without nuclear waste and harm to environment.

5. The first particle of this new class is the neutroid with mean life of 9 seconds being suitable for new activation.

6. A second new particle is pseudoproton [51]-[53], will be generated by compressing an electron in the medium of neutron. The predicted probability of pseudoproton similar to the fact that the experimentally established finite probability for an electron to be "compressed" inside the proton. The new pseudoproton denoted with the symbol $p^-(-1,1,1/2)$ [51]-[53] with reaction

$$n + e^- \longrightarrow p^-(-1,1,1/2). \tag{85}$$

We also have the intermediate state with spin zero called the pseudoprotoid

$$n_\uparrow + e^-_\downarrow \longrightarrow \tilde{p}^-(-1,1,1/2). \tag{86}$$

The relevance of these new particles is evident since they are negatively charged, thus being attracted by nuclei and resolving the central problem of nuclear fusions at large, the Coulomb barrier, as illustrated by the esoenergetic nuclear transmutations without the emission of neutrons

$$\begin{aligned} \mathrm{Ag}(47,107,1/2) + p^-(-1,1,1/2) &\longrightarrow \tilde{\mathrm{Ag}}(46,108,1)[\text{stable isotope}] \\ &\longrightarrow \mathrm{Pd}(46,108,0) + \gamma(0,0,1) \end{aligned} \tag{87}$$

$$\mathrm{Ag}(47,107,1/2)+\tilde{p}^{-}(-1,1,0)\longrightarrow \tilde{\mathrm{Ag}}(46,108,1/2)[\text{stable isotope}]$$
$$\longrightarrow \mathrm{Pd}(46,108,0)+\nu(0,0,1/2) \quad (88)$$

7. The use of the novel technologies based on isomathematics and isomechanics, there is the prediction of additional, heavier composite particles such as the deuteroid and triturid [51, 54]. Further, the use of isomathematcs has permitted the construction of the novel isochemistry that has achieved the first and only known attractive force between identical valence electrons in singlet coupling, resulting in new models of the Hydrogen and water molecules [35, 54, 55] as well as a new two-body model of the helium [56] permitted by Santilli strong valence bond [35, 55].

8. The most important implication of the synthesis of neutrons from a hydrogen gas is the apparent lack of existence of the neutrino in favor of the etherino [36] which is intended as a longitudinal "impulse" (or a quasi-particle) supplying the missing 0.782 MeV from the ether conceived as a universal substratum with extremely high energy density for the characterization and propagation of electromagnetic waves and elementary particles according to the reaction

$$p^{+}+a+e^{-}\longrightarrow n. \quad (89)$$

where $a=a(0,0,0)$ with spin $1/2$. We should also indicate that the etherino hypothesis has no known consistent formulation within the context of quantum mechanics due to its external nature with respect to the Hilbert space and other reasons. By contrast, the covering isomathematics and isomechanics have been formulated to achieve a generalization of the Hilbert space such to include external sources such as the etherino. The possible nuclear transmutations in presence of etherino is

$$\mathrm{N}(Z,A,J)+\tilde{n}(0,1,0)\longrightarrow \tilde{\mathrm{N}}(Z,A+1,J)+a(0,0,0)$$
$$\longrightarrow \mathrm{N'}(Z+1,A+1,J+1/2)\longrightarrow \mathrm{N''}(Z+1,A+1,J) \quad (90)$$

where N' and N" are tabulated nuclides.

9. A very serious thought and an extensive study on etherino is inevitable in regard to how the there is continuous creation of matter in the universe although the extremely large transfer of energy is required in synthesis of neutrons.

8 Concluding Remarks

It is observed that Santilli's novel discovery of hadronic mechanics appropriately explains the Rutherford's conjecture on neutron as a compressed hydrogen atom. He evidently dismissed the neutrino hypothesis and resolved the anomalies pertaining to binding energy, spin and magnetic moment without any theological assumption that the proton and the electron "disappear" at the time of the synthesis. It should also be stressed that the representation is invariant, due to the isounitary character of the model, namely, the numerical values remain the same under the same basic assumptions at different times. After successful mathematical explanation of Rutherford's conjecture on neutron synthesis through novel formulation of hadronic mechanics, Santilli ventured experimentation to strengthen his strong support to the Rutherford model. For experimentation, he adopted the methodology already conceived by Don Borghi and his team for synthesis of neutron from hydrogen gas. After several modifications and repetition of the test, he successfully synthesized neutron and neutrino (the intermediate state before the production of neutron). The neutroids synthesized when reactor is operated at low power. However, after the arc has been turned off, neutriods decay into neutrons in random way at lower power as well. The neutrons are detected by both the detectors employed in the experiment when reactor is working relatively at higher power.

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